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ABSTRACT

This bulletin explains some of the visual characteristics of children and youth, examines critically the vision screening tests used in some schools, and explains the problems resulting from their use. Chapters deal in turn with vision and visual characteristics, the professional eye examination, visual screening tests, problems in referrals from visual screening tests, and organizing a visual screening program. Appendixes illustrate selected aspects of visual behavior and give specific clinical criteria for referral. A glossary is included for technical terms used in the booklet. (AA)

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Screening Vision in Schools

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FOREWORD

This unique gem of a reference for people concerned with screening vision in schools is certain to become a dependable tool and textbook for many years to come. Congratulations to the teacher who reads it early in his career, instead of forty years too late as I have done. It is unique because it gathers together much information which ordinarily comes from widely scattered sources, its reporting is without the usual limitations of viewpoint, its presentation is carefully planned for the lay person, and it is a classic of unclouded exposition. The reader could not be more fortunate.

Screening Vision in Schools prepares the school person for several tasks such as: discussing with trained eye specialists and making plans for visual screening and the evaluation of that screening, selecting a screening test, reading the eye specialists' reports, discussing with trained specialists the cut-off point for those who pass or fail the test, and learning the physical conditions which affect the subject's reading performance in the classroom and the testing-office environments.

The Table of Contents shows the reader a clear outline of the information, from what vision and visual characteristics are, to an annotated table of clinical criteria for referral. Chapter Two includes diagrams of the structure and operation of the eye and introduces the reader to many technical terms he must know in order to understand and communicate with the ophthalmologist and optometrist. The terms are well set in illuminating contexts and are used repeatedly throughout the volume, their meanings enlarged and enhanced in relation to structure and function in human vision. A glossary of almost one hundred terms refreshes the reader when his memory falters.

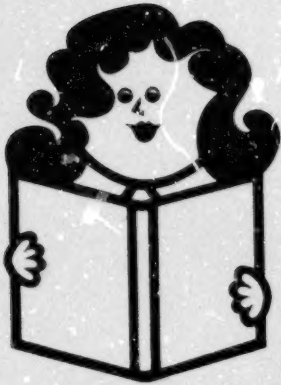
The reader's good fortune is in the authorship. Dr. Fred W. Jobe is an eminent researcher, inventor, consultant, author, and teacher, for many years on the staff of Bausch and Lomb

where he became Director of Ophthalmic Research and Development. High points in his distinguished career include positions as researcher at the South Pole to study ways of assisting pilots to land planes under special weather conditions, designer of new instruments for use in industry and schools, recipient of the Award for Distinguished Services in the educational programs of the American Academy of Ophthalmology and Otolaryngology, and consultant to the Florida State Board of Dispensing Opticians.

This book is a natural consequence of the habit of problem-solving and creative thinking, and of seasoned observation of the communication problems between vision specialists and school persons. It is also, of course, the result of the author's willingness to take his valuable time to write it. The experience of sharing his perceptions is one of learning to trust a genius who infallibly smooths the unfamiliar way without violating the true character of the path.

The International Reading Association is deeply indebted to Dr. Jobe for this generous gift, a milestone in teacher education and professional competence.

CONSTANCE M. MCCULLOUGH



Chapter One

INTRODUCTION

The responsibility of the school is for total development and well-being of the children. In addition to academic progress, schools attend to social and emotional adjustment and to physical development. One of the physical factors about which most school personnel are concerned is adequate and comfortable vision. School people are aware that, as children progress in school, they must rely increasingly on reading and hence upon what and how well they see.

It is the purpose of this bulletin to explain some of the visual characteristics of children and youth, to examine critically the vision screening tests used in some schools, and to explain the problems resulting from their use.

Teachers, supervisors, and administrators are familiar with tests of various kinds. Some use tests of learning aptitude, intelligence, achievement, personality, and other abilities. Many teachers use achievement tests to determine where a pupil ranks on the academic continuum in various school subjects and what is to be achieved next. Such tests, therefore, are no mystery to teachers; but the layman does not understand the purpose of tests nor how to interpret them.

The teacher is usually equally puzzled by vision tests. Why are visual screening tests used? How do they resemble or differ from an eye specialist's examination? Why are there so many differences of opinion about the results? Answers to some of these questions are included in this bulletin.

Most teachers who started to wear glasses about the time they entered school remember vividly certain early, sometimes

traumatic, experiences. Viewed through glasses, their worlds seemed changed. Many things became distorted: doors and windows, which once were straight, became crooked or slanted; the ground seemed to be too far from their fingertips; and stairs presented frightening experiences for small climbers. In some instances, objects suddenly became alarmingly clear and sharp for the first time. Vision was improved—so far as adults could judge—but, to the children, the world was entirely different when viewed through glasses.

The foregoing illustration supports the writer's opinion that defective vision is a misnomer. The child uses his visual mechanism to change the world so that he can function adequately. The addition of glasses, an artificial aid, simply helps everyone to see as much alike as possible.

There are instances where parts of the world are adjusted to common visual characteristics. For example, there is a high incidence of astigmatism among Hebrews. Consequently, their alphabet has heavy strokes in one meridian and thinner strokes in the meridian 90° removed from the first. Thus, the writing was adapted to the "normal vision" of the people.

Preschool children may be perfectly satisfied with their vision because it serves their purposes. Letters that adults discriminate have no meaning for these children until they enter school and are expected to learn to read. In this structured environment, VISUAL DISCRIMINATION becomes important. No longer is it satisfactory for *a*, *e*, and *o* or *x* and *k* to look alike. These letters must be differentiated readily; otherwise reading will become difficult, if not impossible. At this point, some children's vision is no longer adequate to meet their needs.

Lack of adequate vision for the task is not the only reason for inadequate school progress. In fact, it is impossible to estimate the relative value of vision in learning to read. What can be said with some certainty is that vision *can* be a retarding factor and, therefore, any difficulties should be minimized as quickly as possible.

One way to identify children who may need visual care is by using a visual screening test in school. Such tests are designed to separate children into two groups: 1) those who may benefit by referral to an eye care specialist; and 2) those who, according to the test, do not need specialized visual examinations. In general, the visual screening test is intended to select those who have refractive and/or binocular problems. The test is not diagnostic nor is it designed to determine the

cause of the visual problem.

Visual problems are not necessarily visual defects. Indeed, the child with a visual problem can see; his vision, however, may not be adequate for the tasks he is expected to perform. The visual screening test is designed to select individuals whose visual performance does not equip them for the learning task. Of necessity, then, it has a pass/fail gauge. This is the basis for bitter arguments and disagreements relating to visual screening. There is no uniform agreement among vision specialists as to where the cutoff (pass/fail) point should be. If it is set too low, many children will be passed who need visual care. If it is set too high, then too many children will be referred and vision care specialists will find no difficulties. Thus, the test will be criticized for overreferral. Only close cooperation between school personnel and vision specialists can produce a meaningful standard of referral.

Cooperative efforts between school personnel and vision specialists can occur only if the two professional groups can communicate, a condition which implies that the problems of each profession must be understood by the other. One of the deterrents to meaningful dialogue is different professional vocabularies. Therefore, it is necessary to provide teachers with the "language" needed to understand how one sees, what can interfere with adequate vision, and how the vision specialist determines the need for corrective procedures.



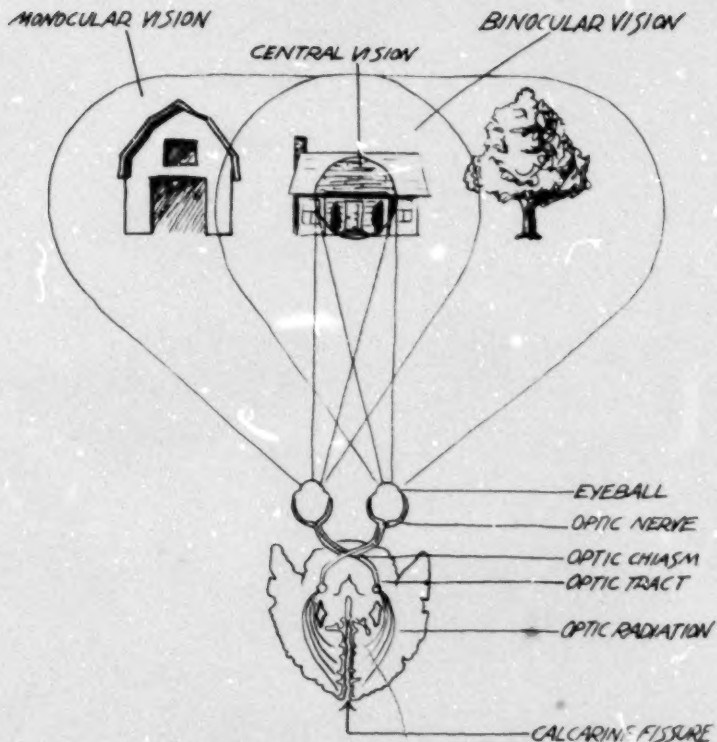
Chapter Two

VISION AND VISUAL CHARACTERISTICS

Seeing is a complex act in which light from an object is focused, by the optical system of the eye, on a sensitive portion (the **RETINA**) of the back of the eye. There, the light energy is transformed by a photochemical process into nerve energy which passes through the visual pathways to the brain, where interpretation of the object occurs. In the broadest sense, seeing is not complete until what is seen can be interpreted by the observer. In many ways, seeing habits are learned as the individual adapts his visual processing to his needs.

The interpretation of what is seen is usually called visual perception. This bulletin will not include a discussion of visual perception, as it is limited to the aspect of clear, comfortable vision and the factors that interfere with it.

Figure 1 is a schematic drawing of how we see. The field of vision shown in the drawing includes a house with a tree on the right and a barn on the left. The field of the right eye takes in the house and the area including the tree. The field of the left eye includes the house and the area including the barn. The house is seen by both eyes and is the binocular field. As shown, the **BINOCULAR** (two eye) field is the overlapping part of the two **MONOCULAR** (one eye) fields. Actually, the field of vision is not as severely limited as it appears from the figure. The total field is the total hemispherical space in front of the face, being limited peripherally by the contours of the nose, eyebrows, and cheeks. The **LENS** of the eye (see Figure 2) forms an image on the retina in the back of the eye. The light energy from the image

Figure 1. VISION

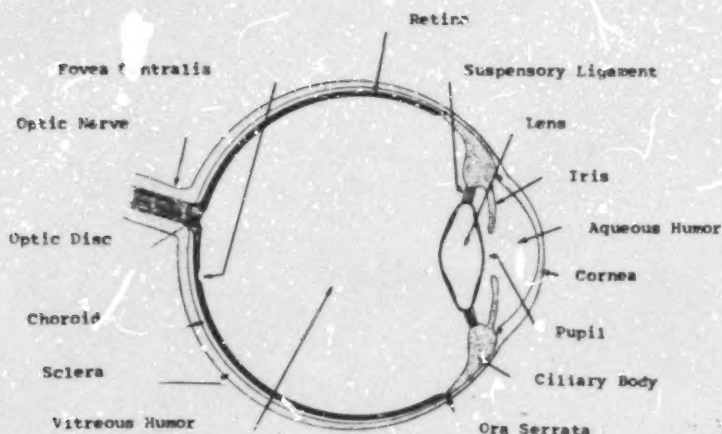
Adapted by permission from CIBA-Geigy Corporation's medical illustration on Vision

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stimulates the nerves and, as shown in Figure 1, eventually affects the cells at the back of the brain.

Anatomy of the eye

The basic organ of sight is the eye. It is approximately spherical in shape and about one inch in diameter with a slight bulge in front. Figure 2 represents a horizontal cross section showing the technical names of the various parts of the eye.

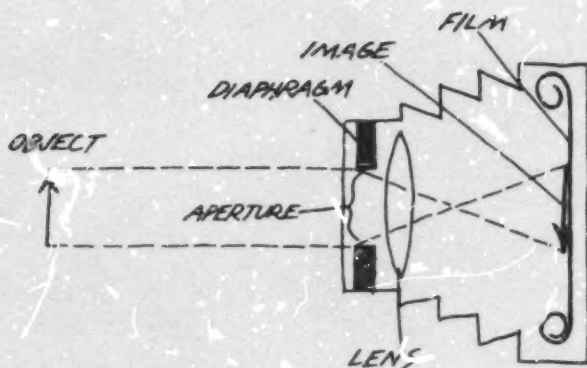
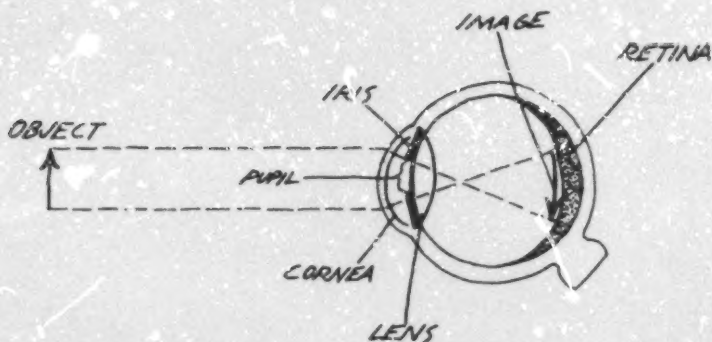
Figure 2. CROSS SECTION OF THE EYE

The frontal bulge, the CORNEA, is transparent and contains no blood vessels when it is healthy. A few millimeters back of the cornea is the colored portion, the IRIS, which has the PUPIL in its center. The pupil appears to be black as it is actually a hole through which light can pass to the interior of the eye. Behind the iris is the CRYSTALLINE LENS. Between the cornea and the iris is the ANTERIOR (forward) CHAMBER which is filled with a water-like fluid known as the AQUEOUS HUMOR.

Surrounding the crystalline lens is the CILIARY MUSCLE to which the lens is attached by fine fibers. This muscle controls the shape and power of the lens. The large chamber behind the crystalline lens is filled with a watery gel called the VITREOUS HUMOR. At the back of the eye, covering approximately three-quarters of the internal surface, is the retina. The retina is very thin, normally transparent, and is an exceedingly complex layer of nerve endings. The nerves from these endings unite and pass out of the eye, forming the OPTIC NERVE.

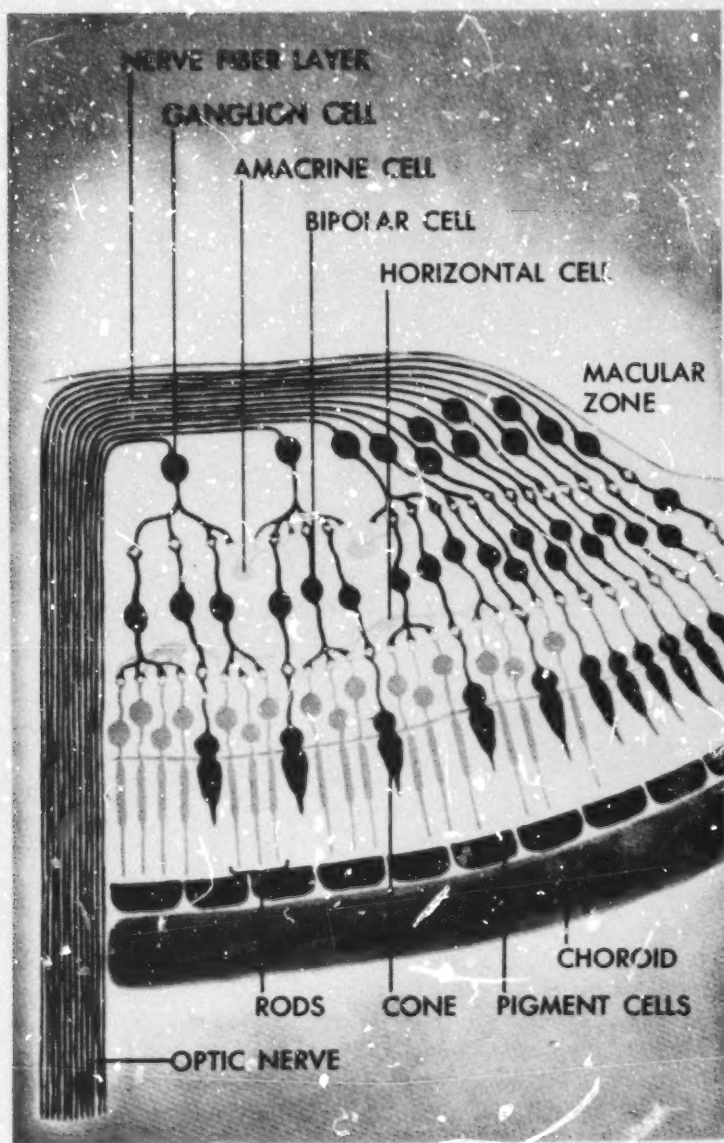
Many times, the eye is compared to a camera (Figure 3); within limits, this comparison is justified. The cornea, iris, and crystalline lens function in a manner similar to the lens

Figure 3. THE EYE AS A CAMERA



elements of a camera. The cornea and crystalline lens are used to form an image of an external object on a light-sensitive layer. This layer is the film in the camera and the retina in the eye. In both, it is essential that the lens system be able to focus so that sharp images can be formed at all distances, from near to far. The changes in focus, called **ACCOMMODATION**, are made in the eye by the crystalline lens changing its shape (and, therefore, its power); a camera focus is changed manually or automatically. The ciliary muscle adjusts the crystalline lens automatically. Finally, the amount of light entering the eye is

Figure 4. THE RETINA



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controlled by the iris changing the size of the pupil, as when one adjusts the size of the shutter opening of a camera. Beyond these comparisons, there is no value in relating the eye to a camera.

The retina of the eye deserves special consideration. It is unique in that the degree of sensitivity varies over its surface. This variation is the result of two types of nerve endings, known as **RODS** and **CONES** because of their general shape (Figure 4). The cones are individually connected to the brain, while many rods may affect one nerve fiber. This dual mechanism is the basis for the **DUPLICITY THEORY** of vision in which cone vision is operative in daylight and rods operate under low illumination.

The distribution of rods and cones varies over the retina. The cones are most abundant in the central area called the **MACULA** and have their greatest concentration in a tiny central area called the **FOVEA**. As seen in Figure 4, each cone has its own pathway to the brain so the foveal area provides the greatest discrimination of the details of an object. Under low illumination, however, the cones are inoperative so that objects directly in front of the eye cannot be seen, while the rods, surrounding the central area, are active. This difference in distribution gives rise to the expression "seeing out of the corner of the eyes." Cones are also responsible for color vision and, since they are insensitive at night, there is loss of color vision under low illumination.

Surrounding the eyeball are six **EXTRAOCULAR MUSCLES**, in antagonistic pairs. These muscles are used to turn the eyeballs in any direction, within limits (Figure 5).

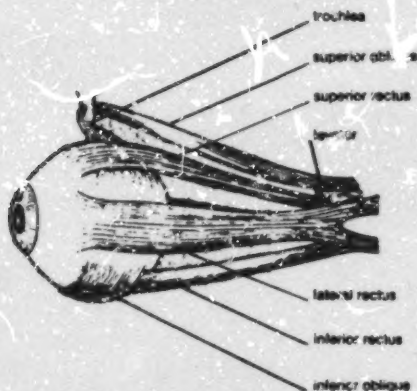
Monocular vision

Each normal, healthy eye has three visual characteristics: 1) light sense, 2) form sense, and 3) color sense. Also, each eye can accommodate to see clearly at all distances.

LIGHT SENSE refers to the ability of the eye to respond to light, or to distinguish a difference in brightness between two lights that differ slightly in intensity. The **LIGHT THRESHOLD** is the least amount of light that the eye can see. The **DIFFERENCE THRESHOLD** is the smallest difference in brightness between two lights that can be recognized as different.

Both the light and difference thresholds depend on the state of the light adaptation of the eye. For example, a common experience when going indoors from a bright sun is that one is

Figure 5. THE EXTRAOCULAR MUSCLES



From P. Kronfeld, *The Eye*, Vol. 1 (1962) Academic Press.

unable to see clearly for a period of time. Another example is that, when the lights in a room are turned off, one is temporarily blind until the eye can adapt to lower illumination.

Reaction to change in illumination is significant in the classroom, but even more important are the lighting conditions under which the child is expected to read or study. Extreme differences in levels of illumination in the field of vision can cause visual discomfort as well as loss of visual discrimination. For example, an object being examined with bright light behind it becomes less visible than if it is examined with less light in the background. Radical differences in illumination should be avoided; likewise, direct reflections of light can reduce visibility. Glare produced by reflection from smooth surfaces should be avoided whenever possible.

SIMULTANEOUS CONTRAST is another related visual phenomenon. For example, a gray object placed on a white background appears to be much darker than if it is placed on a black background. This simultaneous contrast is important in interpreting print on background color.

Light sense is not tested except in unusual circumstances. For example, pilots of military aircraft are screened for light threshold if they are expected to fly at night. Similarly, employees in photographic industries often are screened for

light thresholds. In general, poor NIGHT VISION is not a deterrent in the average school situation except as it may affect performance on tests of the other visual senses. However, light sense is basic to the other two visual senses.

FORM SENSE, as the name implies, is the ability to distinguish details in form. Form sense is usually estimated in the measurement of visual acuity. VISUAL ACUITY at distance is commonly tested by asking the subject to read a series of letters of standard sizes at a distance of 20 feet. The score on the acuity test is usually reported in numbers that resemble a fraction, but they are *not a fraction*. For example, distance acuity of 20/40 means that the smallest letter that the subject was able to read from a position 20 feet away was one that he should have been able to read from a position 40 feet away. The numerator of this so-called "Snellen fraction" is the distance at which the test was made, while the denominator is the distance at which most people are able to read the letter. The Snellen fraction does not imply percent of vision; it is only the symbol to specify visual acuity.

The overall size of the Snellen letter designated as 20/20 is approximately three-eighths of an inch square, while the lines that form the letter are one-fifth the height or width of the letter. Capital letters of the English alphabet are generally used as test targets, with or without SERIFS (the fine horizontal strokes at the top or bottom of the letter). For children who have not learned the English alphabet, the "tumbling E" or "illiterate E" should be used so that the subject can show, with his fingers, the direction in which the three-line strokes of the E are oriented.

The letters just described appear as one line on a test called the Snellen Chart. Each line on the chart is composed of letters of the same size; however, the lines vary systematically in size, with the largest ones in the top line and the smallest ones in the bottom line. In most instances, the charts are designed to equalize the readability of the letters. For example, among letters of equal size, *L* and *T* are easiest to recognize, while *B* is the most difficult.

In addition to the FAR-POINT ACUITY test, NEAR-POINT ACUITY is measured by test cards at some arbitrary distance from the eye, such as 16 inches. The original chart, designed by an ophthalmologist named Jaeger, used different type faces and type sizes, such as pearl and diamond. The smallest type was called J1, the next J2, and so on, to the largest type. This designation is still commonly used, although the original

Jaeger cards no longer exist. Some of the more common near-point charts are marked in both Snellen and Jaeger notations. They may be marked in the Snellen manner, not in a "fraction" as at distance, but in a "decimal fraction." Again, caution is suggested that the number given is a *relative* indication of near-point visual acuity.

Since many factors enter into the measurement of visual acuity, the number or "fraction" reported may be called *apparent visual acuity* because it is the result obtained in a particular testing situation. Differences in measurement may occur because of the size of the test object, the type of test object, the actual distance from the subject to the object, the color of the object, the contrast with the background, the intensity of illumination of the object, and/or the surrounding area. Various standards for all of these factors have been proposed; but, in actual practice, the size of the object is the only one universally held constant. All of the others will vary to some degree from office to office and/or from instrument to instrument. This variation causes discrepancies (i.e. differences) among the results obtained from different testing procedures and conditions.

Visual acuity of 20/20 is referred to as normal; but, considering the possible variations, it would be more accurate to call it average or acceptable. If steps on a test chart had finer gradation of letter size, it is possible that many persons would show acuity better than 20/20. Nevertheless, this score is adequate for all practical purposes.

COLOR SENSE is the third visual characteristic. The normal observer with some training can recognize about 160 hues. It is probable that these hues are the result of combinations of three basic colors responded to by the processes of the retina. The three colors are red, green, and blue-violet. Varying amounts of stimulation of these three processes produce the sensation of other colors. For example, the sensation of yellow is produced by the stimulation of the red and the green processes of the retina.

Color vision is classified in a number of ways. An individual with normal color vision is called a TRICHROMAT (tri=three, chrome=color) or one who sees three colors. Color abnormalities range from the anomalous trichromat (those who do not have perfect hue discrimination) to the MONOCHROMAT (those who see only one color). The major classifications may be described as red-blindness, green-

blindness, and blue-blindness. The first two are sometimes grouped as red-green blindness. The common term "blindness" is a misnomer because none of the three colorblind persons is actually unable to see color; each simply confuses colors. The so-called red-blind and green-blind persons learn to identify grass as green, although they probably get the same color sensation the trichromat gets from a yellow object. The red-green blind person cannot distinguish a red golf tee from green grass, for example. In other words, he confuses the shades of red and green.

Color blindness is inherited and sex-linked, passing from the mother to the son. As a result, about 8.0 percent of boys are color blind while only about 0.5 percent of girls are red-green blind. Blue-blindness is relatively rare in either sex.

Color blindness cannot be corrected; the color-blind person, however, can be trained to recognize variations in color, usually in a way different from that used to train color-normal children. It is very important that color-blind persons be aware of their limitations so that they can learn certain adaptations to their problems.

Color blindness is difficult to test and is seldom considered except in specialized occupations such as railroad engineers, electronic engineers, and other occupations where recognition of color coding is essential. The usual tests for color vision are the various forms of the pseudoisochromatic charts and the Holmgren wool test. The most precise tests are performed with instruments such as the Nagel Anomaloscope.

Teachers should be aware that some children, boys particularly, may be color blind and may experience color confusion. Young children can have severe problems in learning the names of colors. If a teacher asks a child to bring a red book and he brings a green one, this *may* suggest a basic problem in color recognition. Patience with such pupils, rather than condemnation, may help them to make partial adaptations to the problem.

To sum up, light and form senses can be tested separately; but usually the visual acuity measurement is used as an indication of both, while color sense is seldom included in the visual testing procedure.

ACCOMMODATION. In order to have clear vision at all distances the mechanism of the eye must accommodate for the distance of the object to be seen. The eye does this by changing

the power of the crystalline lens within the eyeball. The amount by which the power of the lens can be changed is known as the **AMPLITUDE OF ACCOMMODATION**. The amplitude of accommodation decreases with age.

The range of accommodation refers to the actual distances over which clear vision can be retained by exerting accommodation. For example, if a person can see objects clearly at a distance of twenty feet or more and can see objects clearly at a point four inches from the eye, the range is said to be from infinity to four inches. Amplitude and range of accommodation are expressed in diopters.

DIOPTR is an optical term which is used frequently when discussing the eye, and a full understanding of the term is necessary. Diopter is used in two ways, but at present the discussion will be limited to the use of the term as applied to accommodation. Basically, a diopter is another way of expressing a distance. Normally, distance is expressed in the English system as yards, feet, and inches and in the metric system as meters, centimeters, and millimeters. By definition, a diopter is the reciprocal of the distance in meters; that is, a distance of 1 meter is $\frac{1}{1}$ or 1 diopter. A distance of 2 meters is $\frac{1}{2}$ or 0.5 or one-half diopter. A distance of 0.5 meters is $\frac{1}{0.5}$ or 2 diopters. An extremely long distance would be $\frac{1}{\text{infinity}}$ or 0 diopters.

The range of accommodation given as an example earlier was from infinity (0 diopters) to four inches from the eye. This can be expressed in diopters. Four inches is approximately 100 millimeters or 0.10 meters or $\frac{1}{0.10}$ or 10 diopters. The range, then, is from 0 to 10 diopters. In order to encompass this range, the amplitude of accommodation must be at least 10 diopters. The average twelve-year-old has this amplitude of accommodation. It should be noted that, at infinity, no accommodation should be required to see a distant object clearly. Where the eye is completely relaxed, no accommodation is being exerted. If a distant object can be seen clearly with no accommodation being exerted, the eye is said to be **EMMETROPIC**. In contrast, an **AMETROPIC** eye is one that cannot see a distant object clearly when the accommodation is completely relaxed.

Three ametropic conditions are recognized: 1) hyperopia (hypermetropia), or farsightedness; 2) myopia, or nearsightedness; and 3) astigmatism, which may occur in combination with either of the first two conditions.

A **HYPEROPE** (farsighted person) can see a distant object

clearly but to do so he must use some accommodation. A MYOPE (near sighted person) cannot see a distant object clearly with the unaided eye; in fact the farthest object he can see is a finite distance (i.e., less than twenty feet) in front of him. Both may have the same amplitude of accommodation.

In some ways, it is unfortunate that hyperopia has been called farsightedness. The name indicates that a hyperope has better distance vision than does either the emmetrope or myope. The hyperope can see distant objects more clearly than the myope but not any more clearly than the normal sighted or emmetrope. The term *farsighted* hides the fact that the hyperope can see distant objects clearly only by the constant use of his accommodation. It is somewhat like an individual carrying a suitcase who finds that it drags on the ground if his arm is extended fully. In order to clear the ground, the individual must carry the suitcase with his arm slightly bent or, perhaps, by raising his shoulder. In either case, there is body distortion which can become fatiguing after a time and cause muscular pain. In hyperopia the necessary constant use of the accommodation for distant vision can result in headaches, nausea, DIPLOPIA (double vision), and in mild cases, can cause inattentiveness and inefficient vision. The hyperope also is handicapped for near vision. The normal sighted individual uses three diopters of accommodation to see an object thirteen inches away. A hyperope has to use three diopters plus the amount he has to use for distance seeing. Obviously, this added strain can create near vision problems that may affect his reading skills.

MYOPIA can be named nearsightedness because an uncorrected myope cannot see far distant objects clearly. The myope's distant vision is limited to some finite distance in front of the eye. In extreme cases, this distance can be as short as two inches. The amplitude of accommodation of the myope is, in general, the same as that of an emmetrope (one having to make no accommodation for distant vision) of the same age. The myope uses less than the normal amount of accommodation for near-point seeing and, while this does not affect the near-point clarity of vision, it may adversely affect other attributes of vision.

ASTIGMATISM is caused, in most cases, by the distortion of the surface of the cornea. This distortion of the cornea causes an apparent distortion of an object being viewed. As an example, a point of light such as a star may be seen as a line or

a blurred ellipse. The eye cannot compensate for astigmatism, although some persons can see somewhat more clearly by tilting their heads slightly. This head tilting is seen quite often in the classroom and may be caused by astigmatism. Astigmatism can be corrected with lenses.

The usual cause of hyperopia and myopia is the improper relationship of the length of the eyeball to the power of the optical system of the eye. This refractive error, as it is usually called, can be corrected by using lenses.

Binocular vision

The foregoing description has been limited to the vision of a single eye. The vision of two eyes, or binocular vision, provides more skill in seeing and also can be the source of other types of visual problems.

The primary purpose of binocular vision is to obtain depth perception, known as STEREOPSIS—a very important visual skill. The two eyes are placed laterally with respect to each other so that they receive two slightly dissimilar images of an object. These small differences are interpreted by the brain as differences in depth. The sense of depth is so acute that it is possible for an individual to recognize a difference in distance, along the line of sight, of less than one and one-half inches at twenty feet.

To obtain single binocular vision and depth perception, the images on the retinas of the two eyes must not only be sharp but also be formed on the corresponding parts of the two retinas. The six extraocular muscles of each eye must act smoothly and in conjunction so that the retinal images are placed correctly.

As one looks from one object to another at different distances, the eyes must change accommodation to maintain a clear image and converge or diverge to hold similar parts of the two images on the two foveae. Part of the CONVERGENCE required to maintain clear images as one looks from distant to near objects is associated with the accommodation. But this ACCOMMODATIVE CONVERGENCE is not sufficient to "point" the eyes precisely so that the observer would see a double object, a condition known as double vision or diplopia. In the normal act of seeing, this diplopia is not noticed because additional convergence is exerted to fuse the two images into one, thus obtaining single binocular vision.

Convergence is measured by prism diopters. This is a

second use of diopter. A PRISM DIOPTER is a measure of the deviation of a line of light, or a line of sight. One prism diopter (1Δ) is a deviation of a line of light of 1 centimeter in 100 centimeters, which is a deviation of 1 percent. Assuming that the distance between the two eyes, or the INTEROCULAR DISTANCE, is 6 centimeters, then to obtain a single image of an object 100 centimeters from the subject, each eye must converge 3 centimeters toward the object, making a total of six prism diopters of convergence.

COORDINATION between convergence and accommodation determines comfortable, efficient seeing. Radical interferences in this coordination can have serious and deleterious effects on vision. Two examples of the effects of inefficient coordination of convergence and accommodation may be crossed eyes (STRABISMUS) and/or SUPPRESSION of the vision in one eye (AMBLYOPIA).

If it is impossible for an individual to obtain single binocular vision, one of two adaptations may be made. One adaptation is to rotate one eye until the image in that eye is formed on a relatively insensitive portion of the retina, while the other eye points directly toward the object. The individual who habitually makes this adaptation is called cross-eyed or walleyed, depending on the direction of rotation of the eye. Another adaptation is to ignore what is seen by one eye, which is known as SUPPRESSION. Habitual suppression of one eye results in AMBLYOPIA EX ANOPSIA, or blindness from disuse. In either example, the individual has made a compensation and sacrificed single binocular vision for comfortable monocular vision.

The foregoing examples of strabismus and amblyopia represent extreme adaptations which occur when single binocular vision is too difficult to obtain or to maintain. Less severe interferences with binocular vision may not be obvious but still can seriously decrease visual efficiency.

The relationship between accommodative and FUSIONAL CONVERGENCE is an indication of how much strain is present in obtaining single binocular vision. As was explained earlier, the total convergence is composed of two parts: that due to accommodation, which is about two-thirds of the total and that due to fusion, which is about one-third of the total. Fortunately, these ratios are not absolute; but if the need for fusional convergence is excessive, either on the plus or minus side, visual discomfort may result. Among the symptoms are

headaches and/or nausea after prolonged use of the eyes in close visual tasks. Reduced visual efficiency is less obvious but may occur.

The amount of fusional convergence can be measured by demanding convergence for some fixed distance and then measuring the change in the rotational position of the eyes as fusion is eliminated. A simple test procedure is to ask the subject to look at a point of white light at some near distance, such as 16 inches away, then to place a red glass in front of one eye. At that time the subject will see a white light with one eye and a red light with the other. Since there is no urge to fuse the two lights, they will appear to be separated. Optical prisms are used to bring the two lights together. The strength of the prism required to bring the lights together is a measure of the fusional convergence at that distance. Other methods of measurement may be more exact. Whatever methods are used, the result is known as a phoria measurement. A PHORIA, then, is the tendency for one eye to turn inward toward the eye sighting the object (esophoria), or outward (exophoria), or upward from the sighting eye (hyperphoria), or downward from it (hypophoria). The phorias as a group are known as heterophorias.

If the tendency to turn an eye becomes so pronounced that it is constant, the condition is called a TROPIA. Of course, there are esotropia, exotropia, hypertropia, and hypotropia, corresponding to the phorias.

Orthophoria describes the condition when there is no tendency for one eye to turn away from the other as fusion is destroyed.

Exophoria and esophoria are known as the lateral phorias. Some exophoria (outward turning) is normal at the near point or reading distance. However, excessive amounts of exophoria can be detrimental to efficient vision. The amount of phoria that is normal or excessive cannot be stated in absolute terms. A complete visual examination and professional evaluation are required in order to determine the significance of phorias in relation to other visual skills. There is considerable variation permissible in the lateral (inward or outward) phorias.

The vertical phorias are the hyperphorias (upward) and the hypophorias (downward). Normally, the vertical phoria is expressed as right or left hyperphoria. A right hyperphoria is the same as a left hypophoria. The vertical phorias have much less latitude than the lateral phorias. As a result, the vertical

phorias cause sufficient discomfort that individuals having them are quickly aware that something is wrong and seek professional visual care.

Eye dominance deserves some attention because so much has been written about it. The dominant eye is not necessarily the better eye or the one with most acute vision, but it is the sighting eye. For example, in looking from one object to another, the dominant eye fixates the second object and the nondominant eye follows. The majority of individuals are right-eyed, others are left-eyed, and a few are said to be amb-eyed. Right-eyedness usually accompanies right-handedness and right-footedness, but not necessarily. Mixed dominance (e.g., left-eyedness and right-handedness) is not rare; but it is not necessarily recognized as harmful by the eye care profession. However, it may be somewhat inconvenient. For example, a left-eyed and right-handed marksman has problems using a rifle. Eye dominance is not routinely tested by the eye care professional.

The testing of visual functions varies, to a considerable degree, from specialist to specialist. The plan of testing also varies with the age of the patient. Some of the reasons for these variations will be explained in the next chapter.

Appendix A illustrates some experiments that can be performed to give a better insight into visual behavior. It is recommended that the reader try these simple experiments.



Chapter Three

THE PROFESSIONAL EYE EXAMINATION

Several professional groups are involved with vision and eye care. The three major ones are ophthalmologists, optometrists, and opticians. An ophthalmologist (from Greek word *ophthalmia* for eye) is sometimes referred to as an oculist (from Latin word *oculus* for eye), but that designation is gradually disappearing.

An ophthalmologist is a medical doctor with special training in diseases and refraction of the eye and treatment of the visual mechanism. He must be licensed in the state in which he practices. He is permitted to treat the eye with drugs and to perform surgical procedures.

An optometrist is a graduate of a school specializing in optometry. Likewise, he is licensed in the state in which he practices. He does not treat diseases of the eye but he is educated to recognize them. The optometrist is trained to test visual skills and to institute corrective procedures in the form of corrective lenses and/or visual training.

An optician confines his activities to filling a prescription written by an ophthalmologist or an optometrist. His education and training are designed to enable him to interpret written prescriptions for lenses. Also, he aids his patients in selecting the proper types of lenses and frames. He fits the frame to the patient's face to provide physical as well as optical comfort.

It is not the purpose of this chapter to discuss diseases of the eye. Rather, the purpose is to acquaint the teacher with the methods used to determine the proper optical or orthoptic

treatment required to provide adequate and comfortable vision for the child. Both the ophthalmologist and the optometrist use similar methods for this purpose.

The number of tests given by different eye care specialists may vary, depending on the conditions encountered and the preferences of the examiner. The tests used and the way they are interpreted relate directly to the predictive value of a visual screening test given by a person in school.

There are two general types of examinations used: the objective and the subjective. In the OBJECTIVE EXAMINATION, the eye care specialist uses tests that do not require any verbal responses from the patient. In the SUBJECTIVE EXAMINATION, the patient is expected to answer questions about what he is seeing at different times and under different circumstances.

The first examination given is usually objective. For this purpose, an ophthalmoscope is used to examine the inside of the eye. The ophthalmologist generally will use drops in the eyes (called a cycloplegic) to dilate the pupils of the eyes and to paralyze accommodation. Dilation of the pupil aids in examining the interior of the eye. Paralysis of accommodation insures that it will not interfere with other measurements. The optometrist uses other methods, without drugs, to relax accommodation.

A warning to teachers and parents is in order at this point. If a cycloplegic has been used to dilate the pupil of the eye, the child will suffer temporarily from photophobia (hypersensitivity to light) and will not be able to accommodate to see at near distance. The effects may continue for several days, depending on the drug used. During this time, the child should be protected from excess light by wearing dark sunglasses outside, or even inside a brightly lighted building. He should not be expected to do close work where fine visual discrimination is required. He may, or may not, be able to see clearly at distance.

After the doctor is satisfied that there is no disease of the eye, he begins the refractive examination. The first part is objective, using a RETINOSCOPE. The retinoscope is a hand held instrument containing a small lamp. The doctor stands about two feet away from the patient, points the beam of light at the patient's eye, and observes the light reflected from the retina while the patient looks at an object some distance away. Then the doctor places lenses in front of the patient's eye, continuing to observe the reflected light. The doctor is trained to recognize when the lenses compensate for the errors of refraction of each

eye as it is examined separately. A skillful retinoscopist can estimate quite closely the error of refraction and determine the lens power that will compensate for that error if accommodation is adequately controlled.

The subjective examination follows if the child can recognize and name test objects. The test chart is set at 20 feet from the patient and the doctor changes lenses by small amounts until he is satisfied that the lenses provide the best possible correction of errors.

Following the subjective examination, the examiner may proceed to study the binocular visual habits. The extent of testing depends upon the value placed on binocular habits by the examiner. Many of these tests are difficult to administer to young children. Most often, the binocular tests are limited to the measurement of vertical and lateral phorias. If the child has a history of headaches and/or nausea after prolonged near visual tasks while wearing the proper lens correction, then the vertical phorias are carefully studied. Several test procedures may be used to determine the phorias. All methods consist of eliminating fusion by some means to determine the extent of change in the direction of the lines of sight of the two eyes without fusional convergence.

To observe and further understand the change in the direction of the lines of sight of the two eyes when fusion is eliminated, a teacher may do a brief experiment. The subject should be a child, youth, or young teacher who does not wear glasses. The subject should be asked to look at a small object placed reasonably close (10 to 12 inches) to his eyes. Then one eye is covered with a small card and the subject is instructed not to close either eye and to look intently at the object with the uncovered eye. When the card is quickly removed the eye that has been covered will change direction as the teacher observes. The reason for the change in direction is that when fusion has been eliminated the only convergence present is that related to accommodation. When one eye is uncovered, the two lines of sight must be realigned by a noticeable movement of the eye that was uncovered. If the uncovered eye turns inward, then obviously there must have been a tendency for it to turn out, which is exophoria.

The cover test just described is used by some doctors to estimate the amount of phoria. However, the most common method is to eliminate fusion with a Maddox Rod. It is a red glass disc, one surface of which is formed of polished

cylindrical ribs. When a small point of light is viewed through the Maddox Rod it appears as a thin red line of light perpendicular to the direction of the ribs. When the Maddox Rod is placed over one eye while both eyes are open, an observer will see with one eye a point of light, and with the other, a line of light. If the subject is orthophoric, the line will appear to pass through the point of light. If the Maddox Rod is placed with its ribs horizontal, the line may appear on the right or left of the point of light. By the use of prisms before one eye, the line and point may be brought together. The amount of prism necessary for this alignment is a measure of the lateral phoria. If the ribs are oriented vertically, the same test will measure vertical phoria.

Vertical phorias are not caused by improper visual habits and only small amounts can be tolerated. Consequently, most doctors will prescribe prisms in the glasses to compensate for the deviation. Sometimes all of the vertical phoria will not be shown at the time of the eye examination. If the doctor suspects there is some latent vertical phoria, he may prescribe a patch over one eye to be worn continuously until the next examination.

Although a patient cannot tolerate much vertical phoria, there may be considerable latitude in his tolerance of lateral phoria. In fact, some lateral phoria may be normal when fusional convergence is not operating. As explained earlier, convergent and accommodative functions must act together with some elasticity between them. If one or the other is functioning constantly at the edge of this elasticity limit, then prolonged use of the eyes may reduce visual efficiency or even cause ocular fatigue.

The tests to determine whether accommodation and convergence are within a comfortable relationship are complex and must be performed by a person with professional training in the visual field. Consequently, it is sufficient for teachers to understand that by using prisms and lenses, the doctor can put strain on one function and observe the effect on the other. Of course, the interpretations of the findings are strictly reserved for the ophthalmologist or optometrist.

The desire for fusion is a controlling factor in binocular single vision. Some doctors test fusion and classify it according to one of three degrees specified by Worth (2). The first degree is simultaneous macular vision or the condition where each eye sees an image of an object on its macula at the same time. The

second degree is simultaneous macular vision with superimposition; in other words, the two images are fused. The third degree is when stereopsis, or depth perception, is present. These tests are used especially when orthoptic (or visual) training is being used in order to assess the progress of the training.

The testing procedures just described have been used for distant vision. The same types of tests may be given for near vision. Near-point retinoscopy, sometimes called book retinoscopy, is used predominantly in research but not in routine testing.

If a cycloplegic has been used to suppress accommodation, near-point tests cannot be made at that time since accommodation is impossible. When near-point tests are made, they are usually limited to tests of visual acuity, the phorias, and the range and amplitude of accommodation.

It is widely accepted that correcting far-point acuity will correct near-point acuity in most cases, if the amplitude and range of accommodation are adequate. The problems at the near-point are more likely to be caused by binocular distortions, which will be identified in the binocular tests for phorias and in the accommodative-convergence reserves.

A near-point examination at the time of the tests for distant vision does not necessarily show what the near-point findings will be after the distant vision correction has been worn. Discrepancies occur between near-point tests made before and after far-point correction because many visual skills are learned. When corrective lenses are used at far point, new visual habits are learned (generally called "getting accustomed to the glasses"). Discrepancies may be found, especially in the binocular visual skills measured by the phoria tests.

Following the visual examination, the doctor will write a prescription for lenses which, according to his best judgment, should be worn by his patient, or he will prescribe visual training. There may be various reasons why the total lens power is not prescribed. For example, many doctors do not correct less than one diopter of hyperopia, especially in young children. On the other hand, myopia will usually be fully corrected but care is taken not to overcorrect it. Astigmatism is corrected with CYLINDER LENSES and, except for small amounts, is fully corrected.

The doctor may have specific instructions for the use of

the glasses which should be followed. For example, directions may be "to be worn all of the time," or "to be worn for close work." There are times when bifocals are prescribed for young people. These glasses might be called "treatment" glasses, worn to develop the proper visual habits. The doctor generally checks the child frequently to control the progress of the treatment.

Some visual anomalies are not readily corrected by lenses alone and may require visual training. Just as a child must learn to read from left to right in English, so must the child learn to use his visual skills correctly. The point was made earlier that part of visual behavior is learned. Ordinarily, adequate visual habits develop so that visual efficiency is achieved; but when there has been some interference in this development, the proper habits need to be learned. It may be necessary to recondition the visual functioning by discontinuing one habit pattern and substituting a better one. An extreme example of this treatment is where amblyopia in one eye has resulted from the inability of the two eyes to operate properly together. Sometimes such a condition is called a "lazy eye." In this case, the doctor may have the child cover the good eye to make the amblyopic eye active and restore acuity. When each eye can see well, special kinds of activities are prescribed to develop good binocular vision. Of course, the original cause of the problem must be remedied before the treatment can be successful.

Generally, visual training is a long and arduous process which can be expensive. During this period, the child needs the full support of both the home and the school. Good communication between the doctor on the one hand, and the parents and school personnel on the other, is essential.

Everyone should remember that the doctor determines what is proper for the visual rehabilitation of each child. The doctors are specialists in their fields as are the educators in theirs. One professional group may not understand the problems of the other, but good communication between the two groups will result in maximal visual health for each child.



Chapter Four

VISUAL SCREENING TESTS

Visual screening tests are designed to determine the extent to which an individual's visual performance compares to some predetermined standards. Visual screening of pupils in schools serves several purposes. The results of screening tests 1) identify pupils who may not see effectively; 2) aid the pupils in receiving professional examinations and health care; and 3) call the teacher's attention to the fact that a pupil may be having problems due to inefficient vision and, as a result, enable the teacher to make educational adjustments in school.

Visual screening tests are given to identify those pupils who already have, or may develop, problems requiring the care of a competent eye specialist. The screening tests are administered by the school nurse, teachers, or other persons trained to give the tests and record the findings. Screening tests are not diagnostic and under no circumstances should teachers or nurses attempt to diagnose the visual problem or prescribe treatment. REFERRAL to a vision care specialist is the only acceptable action to take as a result of these screening tests.

There are two general types of visual screening tests: true distance tests, where the test object is physically placed at the correct distance from the child; and simulated distance tests, where the test object is placed at the correct distance by optical means as is done with the stereoscope. Where visual screening tests are not available, teachers' daily observations of children's eye conditions and behaviors have been used. A combination of screening tests and teacher observations is preferred, if

possible.

A number of attempts have been made to provide teachers and the school nurse with a checklist of visual symptoms that would have adequate validity in identifying children in need of professional visual care. Numerous lists, of varying numbers of items, have been suggested but few studies have been made to determine their accuracy.

From a large number of lists of symptoms, Knox (6) found 94 different symptoms suggested by various writers; of these, 30 symptoms emerged as specific, observable, and testable. Knox observed 126 children in third grade classrooms several times while they were engaged in different activities and, on the basis of her observations, she decided which children should be referred for professional examination. Later, each child was given a battery of visual screening tests, and 27 received professional visual examinations. The major conclusion reached was that the number of symptoms was not a good criterion for referral to an eye care specialist. In fact, those children who exhibited a large number of the 30 symptoms might have had emotional problems and should have been referred to a guidance counselor or a school psychologist. Knox also concluded that neither her observation of symptoms nor the battery of visual screening tests alone identified all children in need of visual care, but a combination of the two provided more accurate information.

Since Knox was a trained observer, a second study was made to determine the accuracy with which seven first grade classroom teachers could identify children in need of visual care. Kozlowski (7) enlarged the checklist to 42 items by adding those that teachers might observe over the ten consecutive days on which they recorded symptoms. At the end of this time, each teacher decided which pupils to refer. Again, a battery of visual screening tests was given to all 95 children and nine were examined by a professional refractionist. Kozlowski concluded that classroom teachers, who were untrained observers, were unable to use a checklist of symptoms to identify successfully children who needed visual care.

Results of visual screening tests and the symptoms of visual problems may differ because of the time devoted to each one. The visual screening test could be given at one time which may or may not be most favorable to the child. In addition, children may need an examination for eye conditions other than those included in the screening tests. Such eye conditions

may cause symptoms which teachers can observe over considerable time, and especially after prolonged use of the eyes. Therefore, both visual screening tests and teacher observation are needed because each supplements the other and reduces the probability that a child in need of care is overlooked and not referred to a specialist.

Since most teachers need assistance in determining which symptoms to look for among children, the list provided by the National Society for the Prevention of Blindness (4) is reproduced below:

OBSERVATIONS

1. Eyelids
 - a. crusts on lids among lashes
 - b. red eyelids
 - c. recurring styes or swollen lids
2. Other
 - a. watery eyes or discharges
 - b. lack of coordination in directing gaze of the two eyes
 - c. reddened conjunctiva
 - d. sensitivity to light

BEHAVIOR AND COMPLAINTS

1. Rubs eyes frequently
2. Attempts to brush away blur
3. Has dizziness, headaches, or nausea following close work
4. Is inattentive in chalkboard, wall chart, or map lessons
5. Complains of itchy, burning, or scratchy eyes
6. When looking at distant objects
 - a. holds body tense
 - b. contorts face in attempt to see distant things clearly
 - c. thrusts head forward
 - d. squints eyes excessively
7. When reading
 - a. blinks continually
 - b. holds book too far from face
 - c. holds book too close to face
 - d. makes frequent change in distance at which book is held
 - e. is inattentive during lesson
 - f. stops after brief period
 - g. shuts or covers one eye
 - h. tilts head to one side

- i. tends to reverse words or syllables
- j. tends to look cross-eyed
- k. tends to lose place on page
- l. confuses the following in reading or spelling: *o*'s and *a*'s; *e*'s and *c*'s; *n*'s and *m*'s; *h*'s, *n*'s and *r*'s; *f*'s and *t*'s

It is recommended that teachers record and note the frequency of symptoms such as those suggested above.

TRUE DISTANCE TESTS

The basic test in all visual screening tests, as in all professional examinations, is the distance measure of central visual acuity. It is usually measured by a Snellen Chart which is the best single test available to detect children who have myopia, astigmatism, and, sometimes, hyperopia. The chart is simple to use and relatively inexpensive. However, all that is determined by this test is the clearness of central vision at 20 feet from the child.

As explained in Chapter Two, the Snellen acuity test uses a chart on which square shaped symbols are printed in rows of specified sizes. For reasons explained earlier, the E Chart is preferable. The largest letter at the top should be read by a child with normal vision at a distance of 200 feet. In succeeding rows, from top to bottom, the expected distance for reading the letters is 100, 75, 50, 40, 30, 20, and, sometimes, 15 feet respectively. Each row is marked with the distance or with the "Snellen fraction," 20/100, 20/50, and on down to 20/20 or 20/15.

If a school is to provide its own screening test, using the Snellen Chart, the following equipment should be provided:

1. A Snellen Chart with E symbols.
2. A large single E mounted on a card.
3. A "window" card. This card has a square aperture cut in it so it can be used to isolate a single symbol on the chart.
4. 3x5 inch cards to be used as occluders.
5. Recording forms.
6. A light meter to ascertain the illumination of the chart and the background.

The test should be given in a room set aside for that purpose. The room should be long enough so that the test chart can be hung 20 feet from the child being examined. Illumination of the room and the chart is very important. While there are differences of opinion concerning the proper amount of light, the usual recommendation is 10 foot candles of evenly

diffused light. Glare and shadow on the chart must be avoided. The level of illumination in the testing room should be somewhat lower than that on the chart. As pointed out earlier, bright lights or windows in the direction the child is facing will destroy the dependability of the results.

The Snellen Chart should be hung so that the 20/20 line is at about the eye level of the child. If the child stands to be tested, his heels should be placed 20 feet from the chart; if the child is seated, the rear legs of the chair should be 20 feet from the chart.

Before testing begins, the examiner should explain the test to the child, giving adequate instruction and practice in the direction of the E. The large E card should be used for this purpose and it should be turned in different directions. The child should respond with his hands or arms unless he is absolutely certain of *right* and *left* directions. *Up* and *down* create little problem, so children may respond verbally when the "legs" of the E point these directions.

A standard testing procedure should be established, testing first the left, then the right eye by holding the occluder card first over the right and then over the left eye. Note that each eye is tested separately. The child should be instructed to keep both eyes open during the testing and the examiner should check from time to time to be sure these directions are followed.

Close observation should be made of the eye being tested. Myopes, in particular, tend to squint to see more clearly at distance. They are accustomed to making this extra effort to see at distance and, as a result, they will score higher than they would with their eyes open. When young children are being tested, an assistant is needed to stand at the test chart to indicate the symbol being identified. The window card is designed to isolate a particular symbol.

It is not necessary to use every symbol on the test chart. Begin with the large symbol to be sure that the child understands the procedure. Next, the 20/50 line can be used. If no difficulty is experienced on this line, try the 20/20 line next in order to shorten the testing time as much as possible. However, if the 20/20 line is failed, the examiner should use the preceding 20/30 line.

A pass/fail score on a Snellen is an arbitrary one. Some professionals recommend that a child be marked "fail" unless all of the symbols on the 20/20 line can be identified, while

others will require only four of six correct replies. To determine the proper score for passing and failing, it is important to consult the area vision specialists who should recommend the proper failure score.

The procedure just described with the Snellen test, properly administered, serves to identify myopes, some astigmats, and hyperopes with high refractive errors; however, hyperopes of lesser but still significant amounts of error will pass the test. These results are to be expected because, as explained earlier, the hyperope can use his accommodation to overcome the hyperopia at far distance.

In order to identify children with smaller amounts of hyperopia, a PLUS LENS can be used in giving the test. The purpose for using the plus lens is to determine its effect on CENTRAL VISUAL ACUITY. When the lens is placed before the emmetropic eye, the visual acuity score will be reduced, whereas before the hyperopic eye, the lens will replace the accommodation and permit a good acuity score. The strength of the plus lens to be used for the test has never been standardized but a +1.50 diopter lens is most commonly accepted. A spectacle frame containing two +1.50 diopter sphere lenses may be purchased fairly inexpensively from any optician. When such spectacles are used in visual screening, any part that touches the child's face or ears should be cleaned with alcohol after each child is tested, to meet public health standards.

The plus lens test should be given to all children who pass the Snellen test without lenses, unless they are already wearing glasses. The test with the lenses is conducted just as it was originally without lenses. However, the child fails the test if the visual acuity with the plus lens is equal to or better than the visual acuity without the lens.

When it is used correctly, the Snellen test is an excellent measure of central visual acuity at 20 feet. This test is used by the ophthalmologist and the optometrist in their professional examinations. It is, therefore, favored by the eye care professionals. However, it is limited to testing monocular acuity and cannot be used to screen children for binocular malfunctions.

The Snellen Chart for visual screening in the classroom and the proper use of it have been described in great detail because the chart, or modifications of it, is widely used. Besides, it is the basis for all commercial and recommended

equipment for visual screening.

Over the years, numerous professional articles have condemned the determination of central visual acuity as a criterion for referral of children for professional eye care. For this reason, the Division of Child Hygiene of the Massachusetts State Department of Public Health developed the Massachusetts Vision Test for use in their public schools. It was designed for use with children between the ages of 5 and 18 years. Comparison of the children selected for referral for eye care showed that the Massachusetts Test identified 35 percent of the children tested, while the Snellen Test identified only 20 percent (11).

The Massachusetts Vision Test includes subtests for distance and near phorias, in addition to visual acuity, which probably accounts for the increased percentage of children identified for referral for eye care. This test is no longer sold by the original manufacturer (Welch-Allyn) but so many were made and are still in use in schools that more detailed discussion of it seems warranted. Furthermore, it has been approved officially for use in many states.

The original test has been modified several times and the literature has suggested other changes. An adapted version of the Massachusetts Vision Test incorporating many suggested changes is now available.* Most of the variations were designed to make the test simpler to use and less subject to criticism. Basically, the Massachusetts Vision Test is a kit containing the charts and auxiliary equipment necessary to perform five tests described briefly.

Test 1 *Visual Acuity at Distance.* Snellen Chart forms are used to measure central visual acuity. Usually, testing is limited to the 20/20 and 20/30 lines of symbols. If the examinee can read the 20/20 line, he passes the test. If neither line can be read, the examinee fails the test. If the 20/30 line can be read but not the 20/20 line, the test is scored as a partial failure. When this first test is failed, no further tests are given and the examinee is referred for eye care.

Test 2 *Visual Acuity with Plus Lenses.* This test uses the same targets as Test 1, except the examinee wears a plus lens over the eye being tested. This test is failed if the examinee can read the 20/20 line successfully. If the 20/20 line cannot be read but the 20/30 line can be read, the test is marked as a partial failure. Two partial failures are considered to be

*See list of tests at end of chapter.

one total failure. When this occurs, testing is discontinued and the examinee is referred for eye care.

Test 3 *Phoria Tests at Distance.* The examinee wears glasses with a Maddox Rod over the right eye. The target on the chart is a drawing of a house which is seen by the left eye. A small light in the center of the window in the house is seen as a line of red light by the right eye. First, the glasses with the vertical ribs are used so that the light is seen as a horizontal red line. If the line is seen within the window of the house, the test is passed. However, if the red line appears to be outside the window, the test is failed and the remaining tests are omitted. Second, the glasses with the horizontal ribs are used to produce a vertical red line. If the line passes through any part of the house, the test is passed; otherwise, the test is failed and the examination discontinued.

Test 4 *Phoria at Near Distance.* This test is performed at a distance of 16 inches as measured by a string attached to the test target. The target is a picture of an airplane surrounded by a rectangle. In the center of the rectangle is a pinhole of light. The Maddox Rod lenses with horizontal ribs are used. The test is passed if the vertical line is seen within the rectangle; if it is seen outside the rectangle, the test is failed.

The Massachusetts Vision Test has advantages over the Snellen Test. First, it has standard illumination; second, it is more easily administered and scored; and third, it includes phoria tests for distance and near-point. Finally, the test battery is quite similar to that used in many vision specialists' offices so it has been approved by many eye care specialists for use in schools. However, the test battery has the disadvantage that no more testing is done if the distance acuity test is failed. In such instances, it is equivalent to the Snellen Test for referral purposes. Moreover, when the Massachusetts Test is approved for the use of Test 1 only, it is essentially a Snellen Test with comparable limitations.

SIMULATED DISTANCE TESTS

The second general type of visual screening test is the one in which the test object is placed at the correct distance from the child by optical means. The usual device for this purpose is the STEREOSCOPE.

Several sizes and forms of stereoscopes are available for viewing pictures in three dimensions. It is not a new instrument by any means because years ago the hand-held parlor stereoscope

could be found in many homes. The modern version of the parlor stereoscope, however, is much smaller and uses transparent pictures mounted in a disc.

The stereoscope has been modified to be used as a visual screening instrument. Basically, a stereoscope consists of two side-by-side lenses. A picture, chart, drawing, or object is placed a short distance in front of each lens. The two pictures differ slightly so that the right eye, looking through the right lens, sees a picture similar to what the observer would see if the actual scene were being viewed by that eye. In the same manner, the left eye views a similar but slightly different scene. A SEPTUM, or OCCLUDER, in the center prevents the picture before the right eye from being seen by the left eye and vice versa. In this manner, an observer who looks through a stereoscope has images formed on his retinas in the same manner as though he were viewing the actual scene.

The stereoscopic visual screening test can be placed on a table in a small area. There are other advantages of the stereoscopic tests: first, there is complete control over what each eye sees; second, the apparent distance of the targets can be controlled by the distance of the slides from the lenses of the instrument; and third, the slides are illuminated by lights which are built into the instrument and, therefore, the illumination is standardized. Thus, a stereoscope can reproduce the testing conditions of a 20 foot room. Vision testing charts can be photographically reduced in size and used either as transparencies or as pictures in the instrument. Since the pictures seen by each eye are isolated, it is possible to eliminate fusion by having entirely different targets viewed by each eye.

Because of its versatility, the stereoscope has been used for a number of school visual screening tests. Instruments such as the Keystone Visual Survey Tests, American Optical Company's Sight Screener, Bausch and Lomb's School Vision Tester, and the Titmus School Vision Tester are common examples.*

All of the instruments provide slides for measuring visual acuity with some sort of Snellen forms. While the types of acuity charts differ somewhat with the instrument, they are essentially the same in that the characters are dimensioned according to the Snellen principle. Likewise, the phoria slides generally consist of a horizontal line or arrow in front of one eye and a vertical

*See list of tests at end of chapter.

or slanting line or array in front of the other, although they may differ in appearance. When one is looking through the instrument, the two lines of targets appear to intersect. the point of intersection is an indication of the phoria of the examinee. Usually, there are scale marks on one or both of the lines so that the phoria can be translated into prism diopters.

While both the lateral and vertical phorias could be determined from one slide, two slides are generally used. The reason is that the steps of measurement of the vertical phoria need to be much smaller than those for the lateral phoria. Having two scales on a single slide may be confusing if it uses two different scales.

For visual screening purposes, it is not necessary to have measurements as exact as the prism diopters described above. If the pass/fail standard has been carefully established, it is essential only to determine whether the phorias are within prescribed limits. Therefore, an outline of a rectangular box on the slide before one eye and a point on the other slide may be used. The vertical dimensions of the box are determined by the limits of the vertical phoria and the horizontal dimensions by the limits of the lateral phoria. The placement of the dot on the other slide is determined by the optical constants of the particular stereoscope. For young children, especially, the slides may be made more interesting by using a picture of a chicken or a dog instead of the dot, and a picture of a chicken pen or dog run instead of the rectangle. Then the examinee needs only to tell the examiner whether the animal is inside or outside the pen. This test is relatively easy to administer because even young children who see with both eyes can understand the directions and can respond readily.

The stereoscope can be adapted to screen for near-point visual skills. A near-point distance can be simulated by proper placement of the slides with respect to the lenses. The dimensions of the visual acuity characters and the placement of phoria targets must be different from those of the distance tests to be correct for near-vision tests.

The stereoscopic visual screening test is usually marketed with the proper slides. In addition, a pair of plus lenses are included to determine the presence of hyperopia. As a rule, there is an internal or external means for occluding one eye while the other is tested for acuity. Some screening batteries include additional test slides which may be optional but especially useful for more detailed information about children

with learning problems. Usually, they are more refined tests of binocular coordination. Ordinarily, the slides are designed to determine stereopsis, DUCTIONS, and degrees of fusion. With some instruments, there are tests of ability to determine fusion and the ability to read with each eye and with both eyes.

Tests of depth are made with slides that have right and left sides which are slightly dissimilar but within the normal disparity encountered by the two eyes when viewing a natural scene. As a result, the dissimilarity is interpreted as a normal appearance of depth.

On the other hand, if binocular tests are used in a stereoscopic visual screening instrument where there is gross dissimilarity between the two scenes or characters on the slides before each eye, there is the possibility of RETINAL RIVALRY. For example, an older slide known as the "Bird in the Cage" showed this characteristic. On one slide, there was a cage with the usual bars and, on the other slide, there was a bird. With such great dissimilarity, it was quite common for children to report that the bird disappeared momentarily or that the bars on the cage, or even all of the cage, disappeared and reappeared. Such reports suggest normal behavior of the eyes caused by the rivalry between the two retinas. Apparently, the brain made an effort to explain that two dissimilar objects could not be fused to make sense. Sometimes this type of report has been called SUPPRESSION, which may occur when the two eyes are expected to fuse two dissimilar objects. While the results of such a test may be meaningful under certain circumstances, they do not suggest referral to an eye care specialist. The degree of suppression will vary with the amount of difference in the details between the two sides of the slides, and only when the differences are minimal does the suppression become important.

Essentially, then, the best results in terms of accuracy of referral are obtained in all of the stereoscopic visual screening tests when slides for visual acuity, and phorias are used. The results from additional slides may be helpful if the examinee has a learning problem or if there is reason to believe that the eye care specialists in a particular community want further information. This problem is discussed in Chapter Five.

All of the commercial stereoscopic visual screening tests are accompanied by detailed instructions for their use. These instructions should be followed carefully in order that the results will not be distorted. There are several precautions

which should be followed, regardless of the test used.

1. Each examinee should be alone in the room with the examiner. Otherwise, other children who hear answers may mimic them, giving inaccurate test results.

2. Each child tested alone can more readily establish rapport with the examiner. Only when the child is willing to cooperate fully will the results be dependable.

3. The eye being tested should be observed by the examiner to see if the child squirts to improve his visual acuity. If binocular acuity tests are given, monocular acuity should also be tested by using an occluder over the eye not being tested. The acuity score with the occluder should always be recorded and used as a basis for referral for eye care. As mentioned several times, the eye not being tested should be open and not squeezed shut.

The use of the occluder has been emphasized because that is the way acuity is measured by the eye care specialist and agreement is more likely. Some stereoscopic vision screening tests provide for the measurement of acuity of one eye, while the other eye views a similar scene without the acuity target. However, even with this type of slides, the acuity of the eye being tested may be higher with the other eye completely occluded. Obviously, the higher acuity will be obtained by the eye care specialist and, as a result, accuracy of referral may be questioned.

4. Among children, in the primary grades especially, the examiner must be sure that the INTERLENS DISTANCE on the instrument is sufficient so that both halves of the slides can be seen. Young children often have small INTERPUPILLARY DISTANCE so they cannot see through adult stereoscopes. These children may be very adroit in shifting their heads slightly to look through the lens on the other side.

5. Whenever an instrument is used for viewing an object, whether it be a stereoscope or microscope, there is an instrument effect. The tendency is to accommodate and to converge somewhat, simply because it is obvious that the target is not 20 feet away but quite near. The effects of the stereoscopic instrument on the examinee are a possible reduction in apparent visual acuity and a change in the phoria scores. The instrument effect can be reduced to some extent if the examinee can be convinced that the target is set up as though it is a long way off. The instruments are made as large as is practical to help create this effect.

6. The order of administering tests with a stereoscope can influence the test results, especially those of the phorias. As pointed out earlier, to some extent vision is a learned skill and can be improved with practice. Viewing a stereoscopic target is a form of visual practice which can momentarily influence the phoria test scores. For this reason, the order of administering the tests recommended in the manufacturer's manual should be followed exactly.

7. Whenever inconsistent or doubtful replies are given by the examinee, retesting on another day is suggested. Sometimes children have temporary problems which are alleviated within a short time so that better results are obtained at another time.

The foregoing seven precautions apply to all stereoscopic visual screening tests. To avoid repetition, a detailed description of each one has not been given since they are all built on the same general principles. A list of tests and their manufacturers is supplied at the end of this chapter. All of the suppliers offer literature describing their tests and instructions for their use. Optical companies and opticians serving a particular school area can help in obtaining information.

Summary

This chapter ends without recommending any single visual screening test or battery of tests as superior to others. Instead, two types of tests were discussed: true distance tests and simulated distance tests. Values and limitations of each type have been pointed out. Likewise, precautions in administering visual screening tests have been suggested. This plan was adopted because the research reports dealing with various visual screening procedures have not given consistent results. Besides, there is considerable criticism of schools that refer children for visual care when the eye care specialist finds no problems judged severe enough to correct. The reasons for some of these problems will be considered in Chapter Five and suggestions will be offered as to how each school or school system might proceed to make a wise choice of its visual screening program.

LIST OF TESTS AND MANUFACTURERS

Keystone Visual Survey Tests Keystone View Company, 2212 E. Twelfth
Street, Davenport, Iowa 52803
Massachusetts Vision Test Inquire from Welch-Allyn, Auburn, New York

and American Optical Corporation, Southbridge, Massachusetts 01550
School Vision Tester Bausch and Lomb, Rochester, New York 14602
Sight Screener American Optical, Southbridge, Massachusetts 01550
Titmus School Vision Tester Titmus Optical Vision Testers, 1312 W.
Seventh Street, Piscataway, New Jersey 08854



Chapter Five

PROBLEMS IN REFERRALS FROM VISUAL SCREENING TESTS

A plethora of studies has been made of both single and multiple tests of visual screening. These studies have had two major foci: 1) the relationship of the results of visual screening tests to reading and/or scholastic achievement, and 2) the value of visual screening tests in accurately selecting those children who need a professional visual examination.

Subsequent articles have criticized the research reports as being inadequately planned and executed, poorly organized, and erroneous in their conclusions.

The relationships of the results of visual screening tests to reading and scholastic achievement are not pertinent to this chapter. Those who wish to examine existing studies may find references in Weintraub's annotated bibliography (12).

Limitations of visual screening tests

The majority of studies show that visual screening programs are inefficient in selecting school children in need of eye care. According to the investigators, visual screening tests fail too many children who are not in need of eye care, and pass too many who really need eye care. There is little doubt that the criticism is merited. Likewise, the criterion used by the eye care specialist to determine the need for eye care may not always have been satisfactory.

Children who pass the screening tests but need eye care are called *underreferrals*. Children in this category may continue to be visually handicapped because they are not

referred for a professional eye examination. Furthermore, teachers, parents, and the children themselves may experience false security because the school test "was passed."

Those children who fail the visual screening test but pass subsequent professional examinations are called *overreferrals*. The parents of such children may find a professional examination to be an economic hardship. Parents may express indignation or anger because of the inconvenience of an unnecessary eye examination and question the competence of the school. In addition, overreferrals create an extra burden on eye care specialists, most of whom prefer to use their limited time to help those in need of care.

Some argue that an overreferral is equivalent to having a complete physical examination that shows the child to be in good health, but the two are not equivalent. The annual physical checkup is voluntary on the part of the parents of the child, whereas the referral based on a visual screening test is based on failure on a screening test which is supposed to indicate a definite need for the professional examination.

In the literature, there are arguments about the relative disadvantages of under- and overreferral. In general, those tests that overrefer the largest proportion also underrefer the smallest proportion. It is an argument that cannot be won by either proponent. It depends on whose cat's tail gets shut in the door! However, there is no doubt that the end to be strived for is a reduction in both over- and underreferrals. The causes for such erroneous classifications are worth some explanations in order to find means for reducing the referral errors. Each of the four that follow will be examined:

1. Selection of pass/fail points.
2. Lack of accepted clinical criteria.
3. Screening tests compared to clinical tests.
4. Selection and administration of the screening tests.

SELECTION OF PASS/FAIL POINTS

On a visual screening test, children are placed into one of two categories: pass or fail. The classification would be satisfactory if each visual characteristic had a bimodal distribution. Instead, each distribution is continuous so that it is necessary to identify some artificial point to divide the population. It is difficult to locate the proper score which will fail those children who need eye care and pass those who do not need it. Teachers are aware of this problem when they con-

struct school tests.

In order to solve the problem, two of several suggestions made by Ebel (3:496) apply. "The passing score may be defined on the basis of the pooled judgments of experts on the relevance and difficulty of each item in the test," and "Passing scores cannot be discovered. They must be defined, but the definition should be as clear and as rational as possible." While Ebel was referring to the scoring of educational tests, these two conclusions apply equally to visual screening tests.

One would expect that the eye care specialists would be the experts whose judgments should be pooled. Therefore, it is pertinent to discuss here two items used in visual screening tests and in clinical procedures of the specialists.

As explained in Chapter Three, the eye care specialist measures apparent visual acuity at distances as does the visual screening test. However, the purposes are different. The specialist makes this measurement, to a certain extent, in order to have a record of the visual acuity against which to judge the effects of future treatments and/or lenses. The purpose of the measurement is never to determine whether further tests of visual characteristics are required. Thus, the measurement of distant visual acuity is only one part of a battery of tests. When the results are combined with other measurements, the eye care specialist uses his judgment to decide whether treatment is necessary and determine the treatment needed. In other words, the eye care specialist does not conclude that a child with acuity no better than 20/30 or 20/40 needs eye care. Conclusions are based on the child's age, medical history, and results of the entire test battery.

The differences in functions of the visual acuity tests in the screening battery and the professional battery of tests account for some of the overreferrals. For example, the child whose visual acuity on the screening battery is 20/30 may be considered to be a correct referral or an overreferral. To complicate the problem of correct referrals, a second eye care specialist may disagree with the decision of the first one. Furthermore, one specialist cannot be judged right and the other wrong. Obviously, each one has made a decision based on his training and experience, in considering all of the tests made during the professional examination. In fact, it is possible that the two specialist's decisions might be reversed after examining a second child who has been referred because of visual acuity no better than 20/30 on the screening test.

However, if a child is referred because of visual acuity no better than 20/70 on the screening test, both specialists would consider the referral correct.

The major problem is whether a visual acuity score on screening tests can be found that will be considered correct for referral by almost all eye care specialists. Due to the explanations offered above, it seems doubtful if such a score can be identified. Certainly, some score can be selected that will reduce the number of overreferrals but such a score will increase the number of underreferrals. Obviously, then, it is impossible for a test of visual acuity alone to be an efficient screening procedure if underreferrals are considered as screening errors. Surely, as explained earlier in this chapter, underreferrals should be considered as errors.

The differences in interpretation of the visual acuity scores do not mean lack of significance of this item in the visual screening battery, only that these scores are not as significant as school persons sometimes consider them to be.

Another item in some visual screening batteries is the phoria tests which can become even more controversial than the acuity tests. One reason for controversy is the fact that the results of no other test of visual characteristics are influenced as much by the methods for testing them.

An example of different means for testing phorias may illustrate the source of problems. In Chapter Three, a description was given of the Maddox Rod test of phorias. This test, like all others to determine phorias, depends on dissociating the vision of the two eyes so as to observe or measure the extent of change of lines of sight as fusion is destroyed. In the Maddox Rod test, one eye sees a spot of light while the other eye sees a line of light. The relative position of the spot and the line indicate the amount of phoria. The Maddox Rod test is called a subjective test because the subject being examined must give a voluntary response. Like most subjective phoria tests, the examinee may find it difficult to give definite responses. When the lines of sight of the eyes are dissociated, they tend to wander so that the subject may have difficulty reporting exactly when the line and dot are superimposed.

Another test referred to in the literature for measuring phorias is called the cover test. The subject is directed to look at a source of light. A card is used to cover one eye. When the card is removed, the examiner observes the movement of the eye at the moment it is uncovered. The cover test is called an objective

test because the examinee is not required to make any response, which is considered to be an advantage. The disadvantage of this test is that it requires great skill on the part of the examiner to observe and estimate the amount of movement of the eye as it is uncovered. As with the acuity tests, the critical score for passing and failing must be assigned, and agreement on this critical score is even more difficult to obtain than on the acuity tests.

The foregoing explanation of the difficulties involved in obtaining pooled judgments of eye care specialists to discover the best pass/fail scores illustrates one of the reasons for over- and underreferral of school children and the accompanying criticisms of the visual screening tests.

LACK OF ACCEPTED CLINICAL CRITERIA

In the preceding section, some examples were given for obtaining criteria from eye care specialists. The important point made was that the visual screening tests must simulate the tests given by the eye care specialists, and this is exceedingly difficult. The designer of visual screening tests can base his battery only on tests and expectations of the eye care specialists.

As stated earlier, eye care specialists choose and interpret their professional tests according to their training and experience. Primary differences are often attributed to the differences between ophthalmologists and optometrists. Kelley (5) pointed out some of the following differences which influence the accuracy of referrals based on visual screening tests.

Ophthalmology

1. Primary emphasis on refractive state of the eye with accommodation paralyzed by cycloplegia.
2. Much more emphasis on far-point measurements than measurements made at the near-point.
3. Tendency to emphasize structure and structural defects.

Optometry

1. Emphasis on visual functioning with accommodation operative.
2. Much greater emphasis on near-point measurements and on relation between near- and far-point measurements than in ophthalmology.
3. Tendency to emphasize function and disorders of function.

(page II - 10)

Another statement of the differences between the two professional groups was made by Peters (10:335). He said, "Ophthalmologists reflect their interest and training in eye pathology, squint (and amblyopia), and the more gross

refractive errors by insisting (Vaughan, 1960) that visual acuity testing with the Snellen chart is the only important test which need be performed in schools . . . Optometrists reflect their interest and training in functional vision performance and particularly their interest in near-point performance by insisting that vision screening include not only visual acuity but also tests of coordination between the two eyes, ability to maintain adequate focus at the near point, identification of refractive errors that produce stress in the visual system, as well as organic integrity."

It is questionable whether such lines of demarcation between ophthalmologists and optometrists are as clear as these two authors describe them. In general, however, there are such distinctions but there are overlaps in the tests and methods of examination used by the two professional groups. Perhaps the major distinction is on the emphasis placed on distant versus near tests. Even this distinction is an oversimplification.

In relating far and near acuity, the statement has been made that they correlate no better than does the acuity of the right and left eyes at distance. Based on this argument, some professionals contend that near visual acuity should be measured and referrals for eye care made regardless of the other test results. However, it is much more difficult to define reduced visual acuity at near distance than at far distance. The reason is that the method for measuring distance visual acuity has been standardized, while the methods for measuring near acuity have not. It is universally accepted that in testing distance acuity, the testing distance should be 20 feet or 6 meters, and that the test letter size should conform to the dimensions of the recommendations of Snellen. In contrast, a variety of procedure are used for testing near acuity.

The proper test distance for measuring near acuity is not universally accepted although, generally, it is 16 inches. Even the 16 inch distance is modified, depending on the examinee in the eye care specialist's office. In addition, there is a difference in the targets used. The near-point test chart can be designed and made to subtend the Snellen five-minute angle for a given distance such as 16 inches, but usually the charts are stories printed in lowercase letters that defy classification by true angular size. In Chapter Three, an explanation was given of the near-point charts using type with names such as "pearl" and "diamond" which preceded standardization of type bodies by points.

To complicate further the problems of measuring near acuity, even using 16 inches and block letters subtending the Snellen five-minute angle, visual acuity at near distance is normally less than the 20/20 expected at far distance. In commercial visual screening batteries where near-point visual acuity tests are included, the designer has provided for a given distance for testing, has based the test symbols on the correct Snellen angle, and has set the pass/fail points statistically. Since the eye care specialists are using a variety of testing techniques, satisfactory coefficients of correlation cannot be expected.

Again, emphasis should be placed on the fact that the measurement of visual acuity is not used by the specialist as a major diagnostic tool, but primarily as a base against which to compare the effect of subsequent treatment.

The explanations of the differences in emphasis between ophthalmologists and optometrists, and the serious problems of obtaining near acuity measures for a visual screening test, illustrate the lack of accepted criteria for determining over- and underreferrals on visual screening tests.

VISUAL SCREENING TESTS COMPARED TO CLINICAL TESTS

In the preceding section, some differences have been explained between screening and clinical tests. In addition, the efficiency of visual screening tests is determined by statistical comparisons with tests made by eye care specialists. Criticisms included in studies made always point out that reliability of the screening tests has been established, but the reliability of the professional tests has not—which is not important. The important point is that visual screening tests have internal reliability as well as validity. Normally, validity is determined by how well a test correlates with some standard. Consequently, a visual screening battery cannot be valid unless it has adequate correlation with a professional battery of tests. However, each item of each test need not correlate highly. For instance, the test of visual acuity in the screening test need not correlate highly with the professional visual acuity test, although it probably does. The important point is the accuracy with which the visual screening test predicts the need for a professional visual examination.

There are fundamental differences between the tests given in the visual screening battery and in the professional examination, even though they may be called the same names.

The visual screening tests are performance tests given under prescribed conditions. The professional tests are diagnostic tests given under varying conditions. The visual screening tests cannot determine whether the examinee needs treatment; only the professional can make such a determination. The National Medical Foundation for Eye Care (10:338) underscores this conclusion with the statement, "A sound program will screen out those who should be evaluated and not those who probably require treatment; there will be some referrals of children who, on examination by the physician, will be found not to require treatment."

The closer the visual screening test battery matches the tests given by the vision care specialist, the more efficient the screening test becomes. At the same time, it should be clear that, in general, screening will be done by trained laypersons and not by an ophthalmologist nor an optometrist.

As explained earlier, only visual acuity at distance may be corrected by the eye care specialist in the belief that near acuity will be corrected automatically. Actually, the correction of distance acuity anomalies may cause near-point problems. Earlier, emphasis was placed on the point that, to some extent, vision is a learned skill and that the change of one visual habit may cause disturbance in another. The correction of distance vision by lenses will change near vision habits which may result in such discomfort that retraining is needed. Generally, this change will be reflected in the phoria measurements. The decision as to whether treatment is needed in these instances must be reached by the eye care specialist.

The marked differences in purposes and procedures used in visual screening tests and by eye care specialists make it exceedingly difficult to reduce erroneous classifications on the visual screening tests.

SELECTION AND ADMINISTRATION OF SCREENING TESTS

There is no simple solution to the problem of selecting a visual screening test, or even a battery of tests, to be used in schools. The preceding part of this chapter has explained why difficulties are encountered in visual screening programs and why no existing test battery has been found to eliminate these problems.

Most of the criticisms of screening programs have been based on over- and underreferrals. These erroneous referrals have resulted from tests in the screening battery that are not

equivalent to the diagnostic tests used by the professional eye specialist. In addition, the errors have resulted from the divergence of opinions among the eye care specialists concerning the visual characteristics that should be used to refer pupils for evaluation of vision.

One visual screening program in which there was cooperation between ophthalmologists and optometrists was reported in the Orinda study (1). The battery of tests used in this study approximated the professional examination and, therefore, was called the Modified Clinical Technique. In many ways, this technique approximated the Massachusetts Vision Test except that it used the skiascope (retinoscope) instead of the plus lens to determine hyperopia. The retinoscope, in the hands of trained persons, gives a more accurate estimate of refractive error than does measuring vision through a single plus lens. In the Orinda study, the recommendation is made that visual screening be done by ophthalmologists and/or optometrists. The services of these professionals would be beneficial if it were possible to secure them. In reality, using professional vision care specialists defeats the purpose of having a rapid screening test administered by trained school persons. A school person could be trained to use a retinoscope and then be capable of judging the error of refraction so that a decision could be made as to whether it was sufficient to require further evaluation by an eye care specialist.

In most studies or articles that criticize visual screening tests, reasons are limited for the choices of tests administered. Besides, relatively inadequate descriptions have been given of the administration of the tests. Usually, reference is made to the commercial instrument(s) used and the statement is made that they were administered in the manner prescribed by the manufacturer of the test or test battery. Some manuals accompanying commercial tests appear to assume that the examiner has more background than is offered in the manual. Little, if any, information is given about the qualifications and training of the persons giving the tests.

Another problem in mass test administration, especially of acuity tests, is that often more than one child is in the testing room. Frequently, children can memorize the Snellen chart and some of its adaptations as they listen to the answers given by those who are taking the test.

Test procedures should be as uniform as possible for most children. However, Muskopf and Robinson (8) studied the

problems of test reliability of culturally deprived children and found that, by altering the instructions for giving the test, these children could perform much more consistently. Those persons who prepare visual screening test manuals should ascertain that *all* children are able to understand the directions.

Untrained examiners are likely to increase the number of over-and underreferrals. In an extreme case, scores were reported on binocular tests when the examinee had only one eye! Besides, it would be interesting to know how many underreferrals were myopes who passed the acuity tests at distance by squinting and remained undetected by the examiner. A knowledgeable examiner is as important to the visual screening program as is the battery of tests or the eye care specialist.

Conclusions

Four major factors which result in over-and underreferral by visual screening tests have been discussed in this chapter. These factors apply, to some extent, to all screening tests and lead to criticisms of the tests. For this reason, no single screening test or test battery has proved to be satisfactory.

The Modified Clinical Technique, which approaches the professional examiner's test battery, has had less criticism. It is not feasible in most communities, however, to secure the services of professional eye care specialists to serve the schools in this manner.

In the next chapter, suggestions will be made for instituting a visual screening program which seems to be practical and subject to a minimum of criticism.



Chapter Six

ORGANIZING A VISUAL SCREENING PROGRAM

Organizing an adequate and successful visual screening program for a school or a school system is a complicated procedure. A satisfactory program cannot be started by purchasing some equipment, selecting an available person to use it, and then referring to community eye care specialists those children who appear to pass or fail a quick survey or who have symptoms of difficulty. If this procedure is followed, it will create more problems than it solves. Ultimately, the success of any program depends, not upon a test selected, but upon understanding and cooperation of home, school, and the eye care professions. The purpose of the remainder of this chapter is to suggest steps that may be taken to organize a cooperative program.

Responsibilities of the school

The impetus for setting up, or revising an existing visual screening program, must come from the school. Members of the administrative, guidance, health, or teaching staffs may recognize the need for an adequate screening program. In some instances, a visual screening program is mandated by the school system, the county, and/or the state. Regardless of the origin of the need, some individual or group within the school recognizes the need for a screening program and begins discussions with administrators and teachers.

In many instances, the idea of the program originates with those teachers who must deal with correction and

prevention of learning problems. The reason is that a great deal of research and many written reports have linked learning difficulties to visual anomalies. Except in instances where a researcher plans to study relationships between visual problems and learning, the major purpose of the visual screening program must be to identify, as accurately as possible, all children who need eye care.

When the school staff has decided to explore the initiation of a visual screening program, the next step is to involve the parents of the school population. Each school has its own plan for parent-school relationships, whether it be through a steering committee, PTA meetings, individual or class conferences, or some other plan. Someone who is thoroughly familiar with the complexity of visual screening programs should be invited to consult with the school-parent discussion group. If it is the policy of the school to have student representatives, they should be included. The purpose of such a meeting is not to make decisions concerning any detail of the procedures for visual screening; instead, it is to get cooperation and support in planning a program.

One person or a committee should be designated by the school to take the next steps in planning the program. One individual should contact the eye care specialists who, as explained earlier, determine the effectiveness of the referrals sent to them. This school representative should be capable of great patience, tact, and persuasiveness.

The two groups of community eye care specialists — ophthalmologists and optometrists — may not always agree and, in some instances, may be antagonistic. One highly desirable method for making initial contact is through the county medical or ophthalmological societies and the county optometric society to appoint members for a prospective joint committee whose purpose would be to help plan school procedures for visual screening.

School representatives and eye care specialists are likely to have communication problems when they first meet. Since the school must initiate the program, school representatives need some understanding of vision care and a working knowledge of the technical vocabulary of the eye care specialists. In addition, school persons must become aware of their own technical vocabularies and be prepared to explain them to eye specialists. For example, a standard test has one meaning for school persons but quite another for eye

specialists. The latter group think of a standard test as one accepted in examining eyes. Terms such as *grade scores* or *stanines on tests* may be entirely foreign to the eye care specialists. Therefore, each professional group must develop freedom in asking for explanations when technical terms are used.

The school committee probably will first arrange a meeting of all concerned representatives. School persons must consider the eye care specialists' heavy schedules and set a meeting time convenient for all participants. If the first meeting is held at the school, representatives of the eye care professions should be given the opportunity to examine school facilities for health care and/or possible spaces that could be allotted to visual screening. It may be wise for the person who chairs the first meeting to ask for general assistance ahead of time in preparation for planning the visual screening program. Should specific problems and concerns not be voiced at the first or second joint meeting, the questions suggested below may be presented to the eye care specialists as topics for subsequent meetings.

1. What test(s) should be used to screen for refractive errors?
2. How should test(s) be administered to indicate hyperopia, myopia, astigmatism?
3. What binocular test(s) should be used?
4. What should be the acceptable pass/fail score on each test for referral purposes?
5. Is it necessary to test children who already wear glasses?
6. What qualifications should the school examiner have.
7. What training should be given to the examiner and will the eye specialists take part in that training?
8. How may teachers and/or school nurses select and refer for professional examination those children who might have organic conditions?
9. How should the parents and the eye care specialists be informed of the results of the visual screening tests.
10. What means are to be used to provide the school with the results and recommendations of the eye specialist for each child referred?

In addition to the questions suggested above, others should be added as they are suggested. Input should come from school persons and parents as well as eye specialists,

especially in subsequent discussions. For example, one common misconception of eye specialists is that any school child, even a beginner, knows his letters. Since many younger children and even some older retarded readers may be uncertain of letter knowledge, this information could be supplied along with other data suggested by eye specialists. It should alert them to use an E chart rather than the regular Snellen chart.

The first four questions posed relate to the battery of tests that may be included in the visual screening program. In order to be prepared for the next discussion of the group, the school person(s) responsible for the next meeting should become familiar with some of the problems that may be encountered. For this reason, Appendix B has been added to explain a list of tests and clinical criteria for referral agreed upon by both ophthalmologists and optometrists. The list is taken from the report by Blum and others (1) and is used for illustration only. The list is not to be considered as a recommended one for any school vision program, but it does offer school persons a place to begin their discussion. In order to clarify the meaning of the clinical criteria, each part is discussed separately in Appendix B.

A lively discussion can be anticipated at the meeting that follows. There may be adamant disagreements but in the spirit of cooperation, if necessary, tactful school people should conclude several meetings with answers to the questions which will enable the school to initiate a visual screening program.

Periodic meetings, at intervals agreed upon by the group, should be held to evaluate results after the program has been started. Changes in tests, test administration, pass/fail scores, and other procedures may be anticipated as the results are evaluated.

The participation of parents in these meetings is important. The school child is never referred to the eye specialist directly; instead, it is recommended to the parents that, on the basis of the school test, the child be examined by an eye care specialist. School persons should never refer a child to a specific eye specialist. Sufficient information should be given, however, so that the specialist understands the basis on which the child is being referred for professional examination.

A final responsibility of school persons is to assist children after they have had professional examinations. The school person(s) responsible for screening tests and receiving

reports from eye care specialists must help each child's teacher understand whether the child has a problem, what that problem is, and the nature of the treatment being provided. For example, an eye specialist may recommend that a pupil use glasses only for near-point activities. The teacher may need to remind the pupil to use the glasses until it has become habitual; otherwise, without such reminders, the child may not be helped by the eye care being given.

Responsibilities of the parents

Since children are never referred directly to eye care specialists, parents are told that their child should have a professional eye examination. Usually parents are given a written report of the visual screening tests failed and/or teacher observations on which the referral is based. Parents then are responsible for securing the professional examination and providing treatment if needed, such as eye glasses.

Parents are responsible, also, for informing the school of the results of the professional visual examination when it is completed. In instances where only a verbal report is given, parents should sign a consent form permitting school persons to secure details they need from the eye care specialist. Should the eye care specialist suggest rechecking a child after a given interval, parents should carry out this recommendation.

A number of inexpensive or free clinics are available for parents who cannot afford the services of a professional visual examination. Glasses and other treatments may be supplied to children whose parents cannot afford them. The representatives of the two eye care professions should compile such a list of local services which either they, or the school, can make available to parents who need such information.

Responsibilities of the eye specialists

Both ophthalmological and optometric groups are responsible for helping schools develop the best possible visual screening program. The specialists should provide easy communication with school persons who refer children and perhaps help develop satisfactory referral and report forms to be sent back to school.

While the cooperative program is in operation, eye specialists should keep records of the accuracy of the referrals which have been agreed upon by group representatives. At

preplanned intervals, this information should be supplied to the respective representatives so that the school screening program can be evaluated and revised if necessary. Eye care specialists, in addition, may learn a great deal about school children and their learning problems by maintaining good communication with school persons.

Responsibilities of all groups

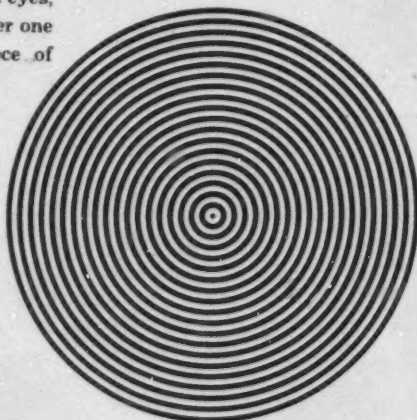
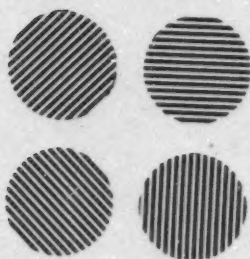
School persons, parents, and eye specialists have a common responsibility to assure each child the opportunity to see as clearly as possible at all distances and to use vision for comfortable reading and study. No single group can achieve this goal alone, but achievement of the most satisfactory results for all children has been shown to be realized through genuine cooperation.

APPENDIX A

ILLUSTRATIONS OF VISUAL BEHAVIOR

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Fred W. Jobe, "See for Yourself," *Focus*, May 1961, 10-13.

All these tests, except those that obviously require the use of both eyes, should be taken first with both eyes, then each eye separately. Cover one eye with the hand or a piece of cardboard—not by squinting.



1

ASTIGMATISM

Uneven curvature of the cornea of the eye will produce astigmatism, one of the commonest visual deficiencies. To a person with astigmatism the lines in the small

circles shown above, at a normal reading distance of 14", will appear unequally black; in the larger circle of concentric rings, there will be pie shaped segments that are blacker and sharper than the remainder of the circle.



2

PRESBYOPIA

Most people in their mid-forties experience a normal condition called presbyopia. This simply means that the crystalline lens of the eye has lost the elasticity it enjoyed when they were young, and cannot easily "accommodate" for both near and far vision. Bifocals provide an easy and comfortable remedy. If your most comfortable reading range is more than 15" or 16" you may be presbyopic.



3

TUNNEL VISION

In driving, one of the gravest visual deficiencies is inability to see objects approaching from the side when looking straight ahead. Hold your arms straight out (180° angle) and wiggle your fingers. If you can discern motion, you have excellent peripheral vision. Now bring them in to a 140° angle and repeat the experiment. If you cannot see motion at this angle, you have a serious problem for which many states would deny a driving license. You need an examination to determine the condition and possible remedies.

This is 6 point Century Schoolbook type reduced photographically to 6, 9, 12, or 18 point. Anyone with 20/20 acuity—the accepted norm for good vision—should be able to recognize each word at a normal reading distance of 14 inches.

This is 6 point Century Schoolbook type. Anyone with 20/40 vision should be able to read it easily at a normal reading distance of 14 inches.

4

NEAR POINT TESTS

Do you have 20/20 vision? If so, you should be able to read the small type reproduced above. Incidentally, 20/20 vision is simply normal vision and not the best possible acuity. If you have 20/40 vision (the criterion for many driving licenses) you should be able to read the paragraph of six point type.

T V H P R U C F N C

5

FAR POINT TEST

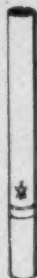
Here is a reasonable acceptable measure of visual acuity for a distance of 10 feet. Inability to distinguish the letters at this distance could be evidence of myopia.



6

BINOCULAR VISION

Here is how to tell whether your two eyes are working together as a team. Hold your two index fingers about 1/4" apart and 8" or 10" in front of the eyes, focusing not on the fingers but on some distant object. The fingers will be out of focus with a sausage shape object appearing between them.



7

DEPTH PERCEPTION

This experiment will simply serve to illustrate stereoscopic vision; only a professional examination will reveal whether you have it. Stand a cigarette on end and try touching it with your index finger, first with one eye covered, then the other. Now do it with both eyes open.

APPENDIX B

CLINICAL CRITERIA FOR REFERRAL*

Characteristic measured	Criteria of correct-referral
[1] Visual acuity	20/40 or less, either eye
[2] Refractive error	
[3] Hyperopia	+1.50 D.S. or more
[4] Myopia	-0.50 D.S. or more
[5] Astigmatism	±1.00 D.C. or more
[6] Anisometropia	±1.00 D. or more
[7] Coordination	
At distance (20 feet)	
Tropia	Any
Esophoria	5 Δ or more
Exophoria	5 Δ or more
Hyperphoria	2 Δ or more
At near (16 inches)	
Tropia	Any
Esophoria	6 Δ or more
Exophoria	10 Δ or more
Hyperphoria	2 Δ or more
[8] Organic	Any verified pathology or medical anomaly of eye and/or adnexa

Note: The bracketed numbers have been added and are explained below.

- [1] Visual acuity. This is the distance visual acuity as measured with the Snellen chart or its equivalent.
- [2] Refractive error. The refractive errors are shown in terms of the power of the lens needed to correct the error except for (6) Anisometropia, where the amount that is shown is the difference between the two eyes. D.S. means Diopter sphere and D.C. means Diopter cylinder. The tests normally used in visual screening do not give an estimate of the amount of the error of refraction except in the case of hyperopia.
- [3] Hyperopia. The amount of the hyperopia would be indicated by the plus lens test of visual acuity.
- [4] Myopia and [5] astigmatism are not measured in the usual school vision testing. Myopia and astigmatism are indicated by lowered visual acuity.
- [6] Anisometropia. The measurement of anisometropia requires clinical test procedures.
- [7] Coordination. The term coordination refers to binocular vision as measured by the phorias. The limiting values are given in terms of prism diopters (Δ). These values can be translated into the amount of deviation shown by the Maddox Rod test.
- [8] Organic. The diagnosis of pathology is outside the province of the school personnel.

*From Blum, Peters, and Bettman, *Vision Screening for Elementary Schools: The Orinda Study*. Berkeley: University of California Press, 1959, 32.

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GLOSSARY

- Accommodation** The act of changing the power of the crystalline lens of the eye so that objects can be seen clearly at different distances.
- Accommodative convergence** The convergence that results from the act of accommodation.
- Amblyopia** Diminished vision not associated with an uncorrected refractive error.
- Ametropia** The refractive condition of the static eye in which a clear image of a distant object is not formed on the retina. Includes hyperopia, myopia, and astigmatism.
- Amplitude of accommodation.** The total change in dioptric power of the eye that can be obtained by the maximum effort of the ciliary muscle.
- Anisometropia** The refractive condition is different in the two eyes.
- Anterior chamber** The space in the eyeball between the cornea and the iris filled with aqueous humor.
- Aqueous humor** The fluid in the anterior chamber of the eye.
- Astigmatism** A refractive condition of the eye where the light from a point source is focused by the eye as two lines at right angles to each other and separated from each other along the line of light.
- Binocular** The term used to describe simultaneous use of the two eyes in the act of vision.
- Binocular single vision** Obtaining a single mental image from the separate images in each of the two eyes.
- Binocular vision** A kind of vision in which the two eyes are related in their movements so that they are both directed at the same point of regard and each contributes to the total perception.
- Ciliary body** An extension of the uvea which is comprised of the ciliary muscle and ciliary processes. Its function is to assist in changing the crystalline lens in the act of accommodation.
- Color sense, color vision** The perception and recognition of color. The classifications of color vision include: *Trichromatic color vision*, manifested by the recognition of approximately 160 hues. *Anomalous trichromatic color vision*, manifested by a slight reduction in the number of hues recognized. *Dichromatic color vision*, where all colors are seen as shades or hues of two colors. (Popularly described as red-green blindness, which is manifested by the confusion of shades of red with shades of green, or blue-yellow blindness, manifested by the confusion of blues and yellows). *Monochromatic color vision*, which is complete lack of color perception (all colors appear as shades of gray).
- Cones** One of the two types of nerve endings in the retina, called cones because of their shape. The cones are tightly packed in the macular area. They are sensitive to color.
- Convergence** The act of turning the two eyes inward in order to see a near object.
- Coordination** The two eyes working together in binocular vision.
- Cornea** The transparent portion on the front of the eyeball.
- Crystalline lens** The lens of the eye situated behind the iris.
- Cylinder lens** A lens having at least one cylindrical or toroidal surface.
- Depth perception** Perception of the relief of objects in which they appear to be in three dimensions rather than as flat pictures.

Dichromat (*see* color sense).

Diopters, lens (*also see* prism diopters) The metric unit used to denote the focal power of an optical system (i.e., the eye or a lens). The power of a lens in diopters is equal to the reciprocal of the focal length in meters.

Diplopia Double vision.

Dominant eye The pointing eye. The eye that takes the lead in looking at an object.

Ductions (prism ductions) The amount by which the convergence of the eyes can be changed by the use of prisms without an associated change in accommodation.

Duplicity theory The theory that there are two types of vision (photopic or day vision and scotopic or night vision) resulting from having two types of nerve endings and nerve connections in the retina.

Emmetropia An eye without refractive error in which visual acuity is at a maximum for distant vision without accommodative effort. An *emmetrope* is a person whose eyes are emmetropic.

Esophoria (*see* lateral phoria).

Esotropia One of the heterotropias in which one eye turns inward.

Exophoria (*see* lateral phoria).

Exotropia One of the heterotropias in which one eye turns outward.

Extraocular muscles The six muscles which cause movement of the eye, internal and external recti, superior and inferior recti, and superior and inferior oblique.

Far-point acuity The visual acuity as measured with a test chart placed 20 feet or 6 meters from the eye.

Focus 1. The point at which the rays of light come together, or appear to come together, after being refracted or reflected by an optical system.
2. To set so as to form a clear image.

Form sense, form perception The ability to perceive form or shape.

Fovea A small pit or fossa.

Fovea centralis The depression in the macular area where visual acuity is keenest (syn. yellow spot).

Fusion The combination of the separate images in the two eyes into a single mental image.

Fusional convergence That part of the act of convergence caused by the desire to form a single mental image from the separate images of the two eyes.

Heterophoria A binocular condition of the eyes in which either eye, when covered, turns in a direction away from the point looked at under ordinary seeing conditions. The turning may be either lateral (lateral phoria) or vertical (vertical phoria). When one eye is covered and it does not turn, the condition is called *orthophoria*.

Heterotropia A binocular condition in which, under ordinary conditions, one eye turns away from the point looked at by the other eye.

Hyperopia (farsightedness) A refractive error of the eye in which a distant object can be seen clearly only by using some accommodation.

Hyperphoria The vertical component of heterophoria. If the left eye turns down when covered, the condition is called *right hyperphoria*. If the left eye turns up when covered, it is called *left hyperphoria*.

Hypertropia The deviation in heterotropia where one eye turns upward.

- Illiterate E** A capital letter E used on a test chart on which lines of Es have the arms pointing in various directions.
- Interlens distance** Used in this booklet to denote the distance between the inside edges of the two lenses in a stereoscope.
- Interocular distance** The distance between the centers of rotation of the two eyes.
- Interpupillary distance (P.D.)** The distance between the centers of the pupils of the eyes when they are looking at a distant object.
- Iris** The colored ring surrounding the pupil of the eye.
- Jaeger chart** A near-point reading chart printed with lowercase letters of graded sizes.
- Lateral phoria** The lateral component of heterophoria where the covered eye turns in (esophoria) or out (exophoria).
- Lens** A transparent medium having two boundary surfaces that are geometrically describable, one of which is curved (spherical, toroid, cylindrical, or aspherical).
- Light sense (light perception)** The ability to perceive light.
- Macula** The rod-free area at the center of the retina. The area of clearest vision.
- Minus lens** A lens having the property of decreasing the convergence of a beam of light impinging upon it.
- Monochromat** (*see* color sense).
- Myopia (nearsightedness)** A refractive error of the eye where the image of a distant object is formed in front of the retina of the static eye. The far point of the myopic eye is at some finite distance (that is, less than 20 feet from the eye).
- Near-point acuity** The visual acuity as measured at some near distance, such as 16 inches.
- Night vision** Vision under low illumination. Generally considered to be the vision under lighting conditions too low for color perception.
- Objective test** A test in which the tester judges the effects of the test situation without any overt reaction from the testee.
- Occluder** A device that blocks off light to one or both eyes.
- Optic nerve** The main nerve to the eye.
- P.D.** Abbreviation for interpupillary distance.
- Phoria** Abbreviation for heterophoria.
- Photochemical** A chemical reaction produced by light energy.
- Plus lens** A lens having the property to increase the convergence of the beam of light impinging on it.
- Presbyopia** A condition of vision resulting from the reduction of the accommodative amplitude due to age. This reduction moves the near point of vision farther from the eye.
- Prism** An optical element used to deviate rays of light. A prism is made of a transparent substance with two surfaces at an angle to each other. A wedge of transparent material.
- Prism diopter** A unit of measurement of angular deviation. One prism diopter (1 Δ) equals the angle subtended by one centimeter at a distance of one meter. Prism diopters are used for measuring the deviation of the lines of sight in heterophoria, heterotropia, and convergence.

- Pupil** An area or aperture in the center of the eye through which light passes into the eye.
- Range of accommodation** The total distance over which clear vision can be obtained by using the accommodation of the eye.
- Referrals** The persons who fail the vision screening test and are recommended for evaluation by a vision specialist.
1. *Overreferrals*. Persons referred for further evaluation who, in the opinion of the vision specialist, should not have been referred.
2. *Underreferrals*. Persons who need evaluation by the vision specialist but passed the screening test and were not referred.
- Refraction** In vision, the clinical measurement of the eye to determine the need for glasses. Measurement of the refractive error.
- Retina** The innermost layer of the eye. The sensitive layer of complex nerve endings upon which light rays are focused.
- Retinal rivalry** The competition for the perceptive attention of the image where there is considerable variance in what is seen by each eye.
- Retinoscope** A hand held instrument used by the eye specialist to measure, objectively, the refractive error.
- Rods** One of the two principal types of nerve endings of the retina; rods are highly sensitive to low variations in illumination but are relatively insensitive to color differences.
- Septum** A partition or dividing wall. The partition used in a stereoscope to separate the fields of view of the two eyes.
- Serifs** The strokes sometimes used at the end of each line of a printed capital letter.
- Simultaneous contrast** The apparent contrast of an object with its background caused by the interaction of the difference in brightness between the object and its surroundings.
- Skiascope** (see retinoscope).
- Snellen chart** A card on which lines of symbols (letters, numbers, tumbled Es, pictures) are printed in graded sizes with the largest symbols at the top of the card. The symbols are constructed to subtend a five minute angle, to the eye, at the specified distance.
- Snellen fraction** The usual method of recording visual acuity where the numerator is the distance at which the test was given and the denominator is the size designation of the smallest Snellen symbol that can be seen.
- Snellen letter** A letter or symbol with overall height and width equal. The height of the symbol will subtend an angle of five minutes of arc at the eye when placed at a specified distance from the eye. The width of the details of the symbol is one-fifth that of the height.
- Stereopsis** The visual perception of three dimensions or depth. The term is generally applied to depth perception resulting from having two eyes separated horizontally so that two slightly disparate images of an object are seen. The disparity is interpreted as three dimensions or depth.
- Stereoscope** An instrument with two eye pieces used for viewing two pictures which are nearly identical (stereogram), one with each eye.
- Strabismus** A condition where one eye fixes on an object and the other eye points in another direction (heterotropia, crossed eyes, squint, walleyed).
- Subjective test** A test that requires the observer to give an overt reaction to

the test.

Suppression An act of ignoring the vision of one eye.

Threshold The lowest level of stimulation that produces a response. The light threshold is the least amount of light that will produce a visual sensation after the eye has been completely dark adapted.

Trichromat (*see* color sense).

Tropia An abbreviation for heterotropia.

Visual acuity Clearness of vision, generally determined by finding the smallest Snellen symbol that can be recognized.

Visual acuity-central The visual acuity determined by looking directly at the acuity test symbols.

Visual discrimination The ability to detect small differences in forms.

Visual screening A test or battery of tests for rapid determination of the need for a more complete visual examination by an eye specialist.

Vitreous humor The watery gel filling the globe of the eye.